A

COLLECTION

of

AVIATION PROGRAMS

used by

MBC FLIGHT DEPT.

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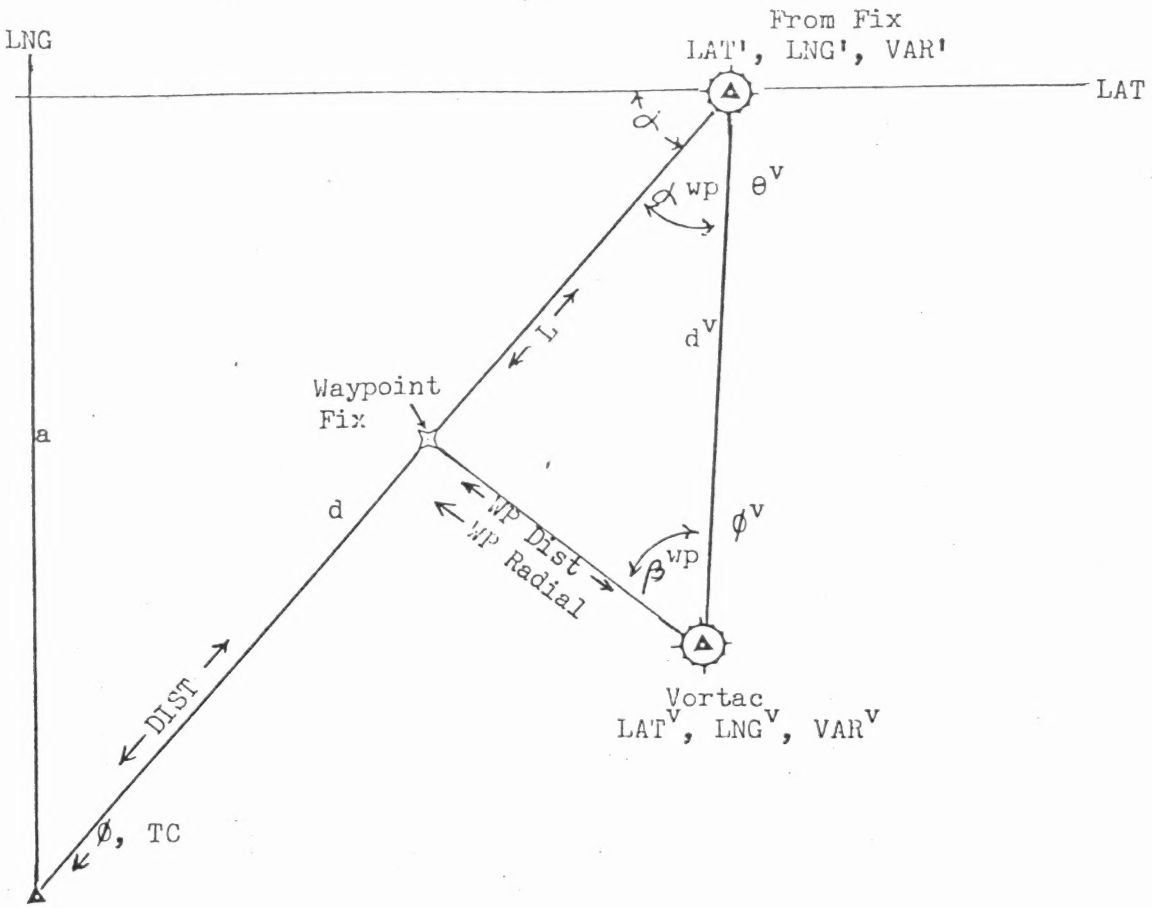
DIAGRAM & EQUATIONS



$$\text{WP Radial} = \theta^v \pm \beta^{wp} + VAR^v$$

$$\text{WP Dist} = 60\ \text{Sin}^{-1}(\text{Sin}\ |\alpha^{wp}|\ \text{Sin}\ d^v)$$

$$LAT = LAT' + \text{Sin}^{-1}(\text{Sin}\ d\ \text{Cos}\ \phi)$$

$$LNG = LNG' - \text{Sin}^{-1}\ \frac{(\text{Sin}\ d\ \text{Sin}\ \phi)}{\text{Cos}\ (LAT - LAT')/2}$$

$$DIST = 60\ d$$

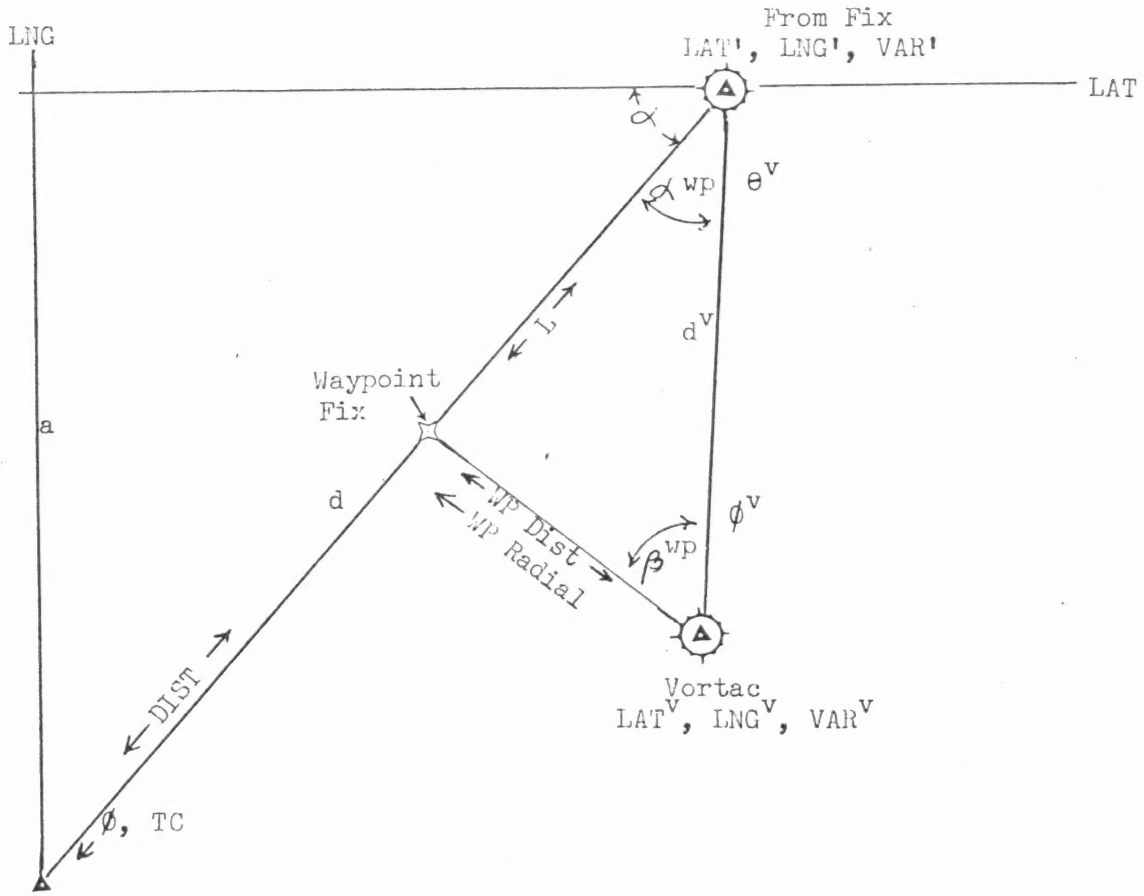
$$d = \text{Cos}^{-1}((\text{Sin LAT Sin LAT' + Cos LAT Cos LAT' Cos (LNG - LNG')})$$

$$a = \text{Cos}^{-1}(\text{Sin LAT Sin LAT' + Cos LAT Cos LAT'})$$

$$\phi = TC = 270^\circ + \alpha \quad \text{or} \quad 90^\circ - \alpha$$

$$\alpha = \frac{\text{Sin}\ a}{\text{Sin}\ d}$$

DIAGRAM & EQUATIONS



To Fix
LAT, LNG, VAR

$$\text{WP Radial} = \theta^v \pm \beta^{wp} + \text{VAR}^v$$

$$\text{WP Dist} = 60 \sin^{-1}(\sin |\alpha^{wp}| \sin d^v)$$

$$\text{LAT} = \text{LAT}' + \sin^{-1}(\sin d \cos \phi)$$

$$\text{LNG} = \text{LNG}' - \sin^{-1} \frac{(\sin d \sin \phi)}{\cos (\text{LAT} - \text{LAT}')/2}$$

$$\text{DIST} = 60\ d$$

$$d = \cos^{-1}((\sin \text{LAT} \sin \text{LAT}' + \cos \text{LAT} \cos \text{LAT}' \cos (\text{LNG} - \text{LNG}'))$$

$$a = \cos^{-1}(\sin \text{LAT} \sin \text{LAT}' + \cos \text{LAT} \cos \text{LAT}')$$

$$\phi = \text{TC} = 270^\circ + \alpha \text{ or } 90^\circ - \alpha$$

$$\alpha = \frac{\sin a}{\sin d}$$

LBL'NAV
TIMS

PROGRAM DESCRIPTION

Program Title NAVIGATION

Contributor's Name Robert A. Tims

Address

City State/Country Zip Code

Program Description, Equations, Variables This program computes course and distance from one fix to another along with intermediate waypoints. Each leg data is displayed as the data is calculated. A waypoint may be calculated over the first and the final fixes.

Any prompt, except for the first one (FROM?) may be declined by resuming program execution with no input. When an input is declined the program will terminate that part and move on to the next phase.

Necessary Accessories Card reader and Printer is recommended

Operating Limits and Warnings Destination must not be point of departure.

LBL'NAV
TIMS

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS

00	True course
01	Scratch/ Data storage pointer/ Sin d_{wp}^{v}
02	Scratch/ Distance/ Data pointer/
03	Scratch/ Counter value/ WP radial
04	WP Dist
05	Leg Dist
06	Identifier
07	VAR'
08	LNG'
09	LAT'
10	IDENT'
11	VAR
12	LNG
13	LAT
14	Departure Ident
15	Total Distance
16 to 30	CARD DATA
31	Leg VAR
32	Leg LNG
33	Leg LAT
34	Leg IDENT

STATUS

SIZE 35 TOT. REG. 162 USER MODE

ENG ___ FIX ___ SCI ___ ON X OFF ___

DEG X RAD ___ GRAD ___

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
05	C	Ident located	
		Easterly Crs $\alpha^{wp} < 0$	Westerly Crs $\alpha^{wp} \geq 0$
06	C	Reference fix	
07	C	Terminal fix is WP	
08	C	Departure fix	
09	C	Computing WP	

ASSIGNMENTS

FUNCTION	KEY	FUNCTION	KEY
XEQ "NAV"	25 (TAN)		

LBL'NAV
END 889 BYTES
TIMS ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
01	*LBL "NAV"	
02	CF 05	Initialize
03	CF 06	
04	CF 09	
05	SF 21	
06	CF 29	
07	ADV	
08	"FROM?"	
09	SF 08	
10	SF 23	
11	XEQ 03	Coordinates
12	CF 08	
13	CLX	
14	STO 15	
15	RCL 06	
16	STO 14	Departure Ident
17	FC?C 07	Not a WP?
18	XEQ 11	Terminal WP
19	FIX 0	
20	*LBL 20	Primary Legs
21	ADV	
22	CLA	
23	ARCL 06	
24	ASTO 10	
25	"⊢ TO?"	
26	CF 23	
27	XEQ 03	Coordinates
28	FC? 23	
29	GTO 22	
30	XEQ 10	TC & Distance
31	STO 00	∅
32	RCL 02	Distance
33	RND	
34	ST+ 15	T/Distance
35	STO 05	Leg Distance
36	RCL 11	
37	STO 31	Store Primary fix
38	RCL 12	
39	STO 32	
40	RCL 13	
41	STO 33	
42	RCL 06	
43	STO 34	
44	0	
45	STO 04	
46	SF 09	
47	*LBL 21	Secondary Legs
48	CLA	
49	ARCL 10	
50	"⊢ TO WP?"	
51	CF 23	
52	XEQ 03	Coordinates
53	FC? 23	
54	GTO 01	
55	"WP:"	
56	ARCL 06	
57	ASTO 06	
58	XEQ 10	
59	STO 02	ϕ^v
60	180	
61	+	θ^v
62	90	
63	RCL 00	ϕ
64	RCL 02	
65	-	α^{wp}
66	1	
67	P-R	$-180^\circ \leq \alpha^{wp} \leq 180^\circ$
68	R-P	
69	RDN	
70	X<0?	
71	SF 05	
72	ABS	$\lvert\alpha^{wp}\rvert$
73	STO 02	
74	-	β^{wp}
75	X<=0?	WP behind starting fix?
76	GTO 21	
77	STO 03	
78	FC?C 05	
79	CHS	
80	+	
81	RCL 11	VAR^v
82	+	WP Radial
83	X<> 03	β^{wp}
84	SIN	
85	RCL 01	Sin d^v
86	*	
87	ASIN	
88	60	
89	*	
90	RND	L
91	RCL 05	
92	X<=Y?	WP beyond ending fis?
93	GTO 21	
94	X<>Y	
95	RCL 04	
96	X>Y?	WP behind last WP?

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

LBL'NAV
END 889 BYTES
TIMS ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
97	GTO 21	
98	RDN	
99	ENTER↑	L
100	X<> 04	WP Distance
101	XEQ 02	Leg output
102	ADV	
103	FIX 1	
104	CLA	
105	ARCL 06	
106	XEQ 15	Output
107	CLA	
108	RCL 03	WP Radial
109	XEQ 12	Azimuth format
110	"⊢, "	
111	RCL 02	$\lvert\alpha^{WP}\rvert$
112	SIN	
113	RCL 01	Sin d^{V}
114	*	
115	ASIN	
116	60	
117	*	
118	ARCL X	
119	"⊢ NM"	WP Radial Distance
120	XEQ 15	Output
121	RCL 11	VAR update
122	STO 07	
123	ADV	
124	FIX 0	
125	RCL 06	
126	STO 10	
127	GTO 21	
128	LBL 01	
129	CF 09	
130	RCL 31	VAR update
131	STO 11	
132	RCL 34	
133	STO 06	
134	RCL 05	
135	RCL 04	
136	XEQ 02	Leg output
137	RCL 11	
138	STO 07	
139	RCL 32	Recall Primary Fix
140	STO 08	
141	RCL 33	
142	STO 09	
143	GTO 20	
144	LBL 02	Leg Output Subroutine
145	-	
146	STO 12	Secondary leg distance
147	CLA	
148	ARCL 10	
149	FC? 55	
150	GTO 00	
151	ACA	
152	CLA	
153	SF 13	
154	" TO "	Preface
155	ACA	
156	CF 13	
157	CLA	
158	LBL 00	
159	FC? 55	
160	"⊢-"	
161	ARCL 06	
162	XEQ 15	
163	"MC="	
164	RCL 00	ø
165	RCL 07	VAR'
166	+	MC'
167	STO 13	
168	XEQ 12	Azimuth format
169	RCL 13	MC'
170	RCL 00	ø
171	RCL 11	VAR
172	+	MC
173	X≠Y?	
174	"⊢/"	
175	X≠Y?	
176	XEQ 12	Azimuth format
177	XEQ 15	Output
178	"DIST="	
179	ARCL 12	Leg Distance
180	"⊢ NM"	
181	GTO 15	Output
182	LBL 03	Coordinate Input Subroutine
183	13	
184	FS? 08	
185	9	
186	LBL 04	
187	STO 01	
188	LBL 05	
189	AON	
190	PROMPT	
191	AOFF	
192	FC? 23	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

LBL'NAV
END 389 BYTES
TIMS ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
193	RTN	
194	FC? 09	
195	CF 07	
196	ASTO 06	
197	16.03003	
198	STO 02	
199	STO 03	
200	XEQ 06	Search for data
201	FS?C 05	Found?
202	RTN	
203	RCL 03	
204	STO 02	
205	SF 25	
206	AON	
207	RDTAX	
208	AOFF	
209	CF 25	
210	XEQ 07	Search for data
211	FS?C 05	Found?
212	RTN	
213	CF 22	
214	CLA	
215	ARCL 06	
216	"⊢ LAT?"	
217	PROMPT	
218	CLA	
219	ARCL 06	
220	FC? 22	
221	GTO 09	
222	HR	
223	STO IND 01	
224	DSE 01	
225	CLA	
226	ARCL 06	
227	"⊢ LNG?"	
228	PROMPT	
229	HR	
230	STO IND 01	
231	DSE 01	
232	CLA	
233	ARCL 06	
234	"⊢ VAR?"	
235	PROMPT	
236	STO IND 01	
237	RTN	
238	*LBL 06	JBR?
239	RCL 06	
240	"JBR"	
241	ASTO Y	
242	CLA	
243	ARCL 06	
244	X≠Y?	
245	GTO 07	
246	10	
247	STO 02	
248	35.4952	
249	STO 11	
250	-903847.04	
251	STO 12	
252	GTO 08	
253	*LBL 07	Ident Search
254	RCL 06	
255	RCL IND 02	
256	X=Y?	
257	GTO 08	
258	ISG 02	
259	GTO 07	
260	RTN	
261	*LBL 08	Decode coordinates
262	SF 05	
263	1	
264	ST+ 02	
265	RCL IND 02	
266	HR	
267	STO IND 01	
268	DSE 01	
269	1	
270	ST+ 02	
271	RCL IND 02	
272	FRC	
273	LASTX	
274	INT	
275	ABS	
276	1 E4	
277	/	
278	HR	
279	STO IND 01	
280	DSE 01	
281	RDN	
282	100	
283	*	
284	STO IND 01	
285	RTN	
286	*LBL 09	Intersection coordinates
287	FC? 09	WP?
288	FS? 06	Reference fix?

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

LBL'NAV
END 889 BYTES
TIMS ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
289	GTO 03	
290	RCL 07	
291	STO 11	
292	RCL 08	
293	STO 12	Prior fix to be used for
294	RCL 09	the reference fix if
295	STO 13	needed.
296	RCL 06	
297	STO 31	
298	SF 06	Referance fix flag
299	CF 23	
300	13	
301	"NEED FIX?"	
302	XEQ 04	Reference coordinates
303	CF 06	
304	RCL 31	
305	STO 06	
306	"FIX MC?"	
307	PROMPT	
308	CLA	
309	ARCL 06	
310	SF 23	
311	FC? 22	
312	GTO 03	
313	RCL 11	
314	FS? 08	
315	STO 07	
316	-	
317	STO 01	
318	"FIX DIST?"	
319	PROMPT	
320	60	
321	/	d
322	SIN	
323	STO 02	Sin d
324	RCL 01	Ø
325	SIN	
326	*	
327	ASIN	
328	RCL 01	
329	COS	
330	RCL 02	
331	*	
332	ASIN	
333	RCL 13	
334	+	
335	STO 13	LAT
336	FS? 08	
337	STO 09	
338	LASTX	
339	+	
340	2	
341	/	
342	COS	
343	/	
344	ST- 12	
345	RCL 12	LNG
346	FS? 08	
347	STO 08	
348	SF 07	
349	RTN	
350	*LBL 10	TC & Distance Subroutine
351	RCL 13	
352	SIN	
353	RCL 09	
354	SIN	
355	*	Sin LAT Sin LAT'
356	STO 01	
357	RCL 13	
358	COS	
359	RCL 09	
360	COS	
361	*	Cos LAT Cos LAT'
362	STO 02	
363	+	
364	ACOS	
365	SIN	
366	RCL 13	
367	RCL 09	
368	-	
369	SIGN	+ Northerly
370	*	- Southerly
371	RCL 02	
372	RCL 12	
373	RCL 08	
374	-	
375	X<0?	+ Westerly
376	SF 05	- Easterly
377	COS	
378	*	
379	RCL 01	
380	+	
381	ACOS	d
382	SIN	Sin d
383	STO 01	
384	LASTX	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

LBL'NAV
END 889 BYTES
TIMS ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
385	60	
386	*	DIST
387	STO 02	
388	RDN	
389	/	
390	ASIN	α
391	FS? 05	
392	CHS	
393	90	
394	+	
395	180	
396	FS?C 05	
397	CLX	
398	+	$\emptyset$
399	RTN	
400*LBL	11	Terminal WP Subroutine
401	RCL 06	
402	STO 10	
403	CLA	
404	ARCL 06	
405	"⊢ WP?"	
406	SF 09	Computing WP flag
407	CF 23	
408	XEQ 03	Coordinates
409	CF 09	
410	FC? 23	
411	RTN	
412	"WP:"	
413	ARCL 06	
414	ASTO 06	
415	CLA	
416	ARCL 10	
417	"⊢ * "	WP Preface
418	ARCL 06	
419	XEQ 15	Output
420	CLA	
421	RCL 10	
422	STO 06	
423	XEQ 10	$\emptyset^V$
424	180	
425	+	θ^V
426	RCL 11	VAR^V
427	+	
428	FIX 1	
429	XEQ 12	Azimuth format
430	"⊢, "	
431	RCL 02	d^V
432	ARCL X	
433	"⊢ NM"	
434	GTO 15	Output
435*LBL	12	Azimuth Subroutine
436	360	
437	MOD	
438	X≠0?	
439	GTO 00	
440	LASTX	
441	+	
442*LBL	00	
443	100	
444	X>Y?	
445	"⊢0"	
446	SQRT	
447	X>Y?	
448	"⊢0"	
449	ARCL Y	
450	FC? 55	
451	RTN	
452	ACA	
453	0	
454	ENTER↑	Degree Character
455	BLDSPEC	
456	6	
457	BLDSPEC	
458	9	
459	BLDSPEC	
460	9	
461	BLDSPEC	
462	9	
463	BLDSPEC	
464	6	
465	BLDSPEC	
466	ACSPEC	
467	CLA	
468	RTN	
469*LBL	22	
470	FC?C 07	Not a WP?
471	XEQ 11	Terminal WP
472	ADV	
473	CLA	
474	ARCL 14	
475	"⊢ TO "	
476	ARCL 34	
477	AVIEW	
478	FIX 0	
479	"T/DIST "	
480	ARCL 15	

LBL'NAV
END 899 BYTES
TIMS

PROGRAM LISTING

■ 41C

STEP/ LINE	KEY ENTRY	COMMENTS
481	FS? 55	
482	"⊢ NM"	
483	♦LBL 15	
484	FC? 55	
485	GTO 00	
486	ACA	
487	PRBUF	
488	RTN	
489	GTO "NAV"	
490	♦LBL 00	
491	AVIEW	
492	END	

```
LBL'NAV
*TIMS*
PRINTED RESULTS FROM THE
SAMPLE PROBLEM GIVEN IN:
LBL'AVNAV

PBF * WP:PBF
182.2°, 4.4 NM

PBF to WP:LIT
MC=032°/031°
DIST=17 NM

WP:LIT
121.1°, 27.6 NM

WP:LIT to HILLE
MC=031°/032°
DIST=53 NM

HILLE to JBR
MC=023°
DIST=48 NM

JBR * WP:ARG
134.3°, 22.4 NM

PBF TO JBR
T/DIST 118 NM
```

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

LBL'AVNAV
TIMS

PROGRAM DESCRIPTION I

Program Title Aviation Navigation

Contributor's Name Robert A. Tims

Address

City State/Country Zip Code

Program Description, Equations, Variables This program computes course and distance from one fix to another along with intermediate waypoints. The individual legs and the associated data is stored in proper sequence, each leg in 5 data registers.

Wind and altitude is prompted for. If altitude input is declined, the prior altitude is entered. The prior altitude is displayed in the prompt. The winds aloft, above and below the altitude, are prompted for; the lower wind first. If input is declined, the prior leg's wind is entered. Input cannot be declined the first leg or when the altitude is changed. If the upper wind is declined, the input for the lower wind is used. The wind at the flight level is interpolated from the input winds. Winds are entered in the same format is given in the winds aloft forecast.

When a fix input is declined the program will terminate that part and move on to the next phase. "FROM?" prompt input cannot be declined.

Necessary Accessories Card Reader is recommended.

Operating Limits and Warnings Destination must not be point of departure.

LBL'AVNAV
TIMS

PROGRAM DESCRIPTION II

Sample Problem (Sketch if Desired)

Flight: Depart Pine Bluff airport and fly direct to Hille intersection than direct to Jonesboro airport. Climb to 3500' until the waypoint off of Little Rock VOR than climb to 7500'. Hille intersection is PBF03466.

Winds:	3000	6000	9000
LIT	1512	1718	2022
MEM	1810	2118	2525

Data from WBAZ: Fuel is 118 Gal.
GW is 5,091 lbs.

Terminal fixes off of PBF VOR and Gilmore VOR.

SOLUTION:

	Comments
R10= 54 R14= 7500 R15= 118 R19= 206 R20= 150.012 R21= 262 R22= 189.0123493 R31= -4 R33= WP:GQE R34= 3402.030189 R35= 118 R36= 5091 R37= WP:PBF R38= 1822.004358 R39= PBF R40= 1211.027575 R41= 36.017 R42= -3500.004 R43= 153.013 R44= WP:LIT R45= 0 R46= 36.053 R47= -7500.005 R48= 185.020 R49= HILLE R50= 0 R51= 27.048 R52= -7500.004 R53= 230.0215 R54= JBR *LOAD AVFLY*	PERTINENT DATA REGISTERS AVNAV RESULTS USED LATER IN THE AVFLY PROGRAM

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS

00	True Course		
01	scratch		
02	scratch		
03	scratch		
04	WP Distance		
05	Leg Distance		
06	Identifier		
07	VAR'		
08	LNG'		
09	LAT'		
10	Leg Counter		
11	VAR		
12	LNG		
13	LAT		
14	Altitude		
15	Total Distance		
16		19	Departure Elev.
-to-	Card Data	20	Climb Wind
30		21	Destination Elev.
31	Leg Var	22	Descent Wind
32	Leg Lng		
33	Leg Lat	33	Dest. WP Ident
34	Leg Ident	34	Dest. WP Fix
35	Reserved for Fuel		
36	Reserved for GW		
37	Depart. WP Ident		
38	Depart. WP Fix		
39	Leg #1 Ident		
40	WP Fix		
41	Crs.Dis		
42	Alt.Var		
43	Wind data		
44	Leg #2		
-etc.-			
(39+5N), N is the number of legs			

STATUS

SIZE 40+5N TOT. REG. 142 + USER MODE

ENG ____ FIX ____ SCI ____ ON X OFF ____

DEG X RAD ____ GRAD ____

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
05	C	Ident located	
		Easterly crs $\alpha^{wp} < 0$	Westerly crs $\alpha^{wp} \geq 0$
		Alt.>12,000'	
		Lower wind only	
06	C	Reference fix	
		New altitude	
07	C	Terminal fix is WP	
08	C	Departure fix	
09	C	Computing WP	

ASSIGNMENTS

FUNCTION	KEY	FUNCTION	KEY
XEQ "AVNAV"	25 (TAN)		

LBL'AVNAV
END 994 BYTES
TIMS 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
01	*LBL "AVNAV"	
02	FIX 0	
03	CF 05	
04	CF 06	
05	CF 09	
06	CF 29	
07	"FROM?"	
08	SF 08	
09	SF 23	
10	XEQ 01	Coordinates
11	CF 08	
12	RCL 06	
13	STO 39	
14	CLX	
15	STO 14	Initialize
16	STO 15	
17	STO 38	
18	38	
19	FC?C 07	Not a WP?
20	XEQ 08	Terminal WP
21	RCL 33	
22	STO 06	Recall ident
23	39	
24	STO 10	Leg counter value
25	*LBL 20	Primary leg
26	CLA	
27	ARCL 06	
28	ASTO IND 10	
29	"⊢ TO?"	
30	CF 23	
31	XEQ 01	Coordinates
32	FC? 23	
33	GTO 23	
34	XEQ 07	TC & Distance
35	STO 00	$\emptyset$
36	RCL 02	Distance
37	RND	
38	ST+ 15	T/Distance
39	STO 05	Leg distance
40	RCL 11	
41	STO 31	Store primary fix
42	RCL 12	
43	STO 32	
44	RCL 13	
45	STO 33	
46	RCL 06	
47	STO 34	
48	0	
49	STO 04	
50	SF 09	Computing WP's
51	*LBL 21	Secondary Legs
52	CLA	
53	ARCL IND 10	
54	"⊢ TO WP?"	
55	CF 23	
56	XEQ 01	WP Coordinates
57	FC? 23	
58	GTO 22	
59	XEQ 07	TC & Distance
60	STO 02	$\emptyset^V$
61	180	
62	+	θ^V
63	90	
64	RCL 00	$\emptyset$
65	RCL 02	
66	-	α^{wp}
67	1	
68	P-R	$-180^\circ \leq \alpha^{wp} \leq 180^\circ$
69	R-P	
70	RDN	
71	X<0?	
72	SF 05	
73	ABS	$\lvert\alpha^{wp}\rvert$
74	STO 02	
75	-	β^{wp}
76	X<=0?	WP behind starting fix?
77	GTO 21	
78	STO 03	
79	FC?C 05	
80	CHS	
81	+	
82	RCL 11	VAR^V
83	+	WP radial
84	X<> 03	β^{wp}
85	SIN	
86	RCL 01	Sin d^V
87	*	
88	ASIN	
89	60	
90	*	
91	RND	L
92	STO 12	
93	RCL 05	
94	X<=Y?	WP beyond ending fix?
95	GTO 21	
96	X<>Y	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

LBL"AVNAV
END 994 BYTES
TIMS 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
97	RCL 04	
98	X>Y?	WP behind last WP?
99	GTO 21	
100	1	
101	ST+ 10	
102	RCL 03	WP radial
103	360	
104	MOD	
105	10	
106	*	
107	RND	
108	RCL 02	
109	SIN	
110	RCL 01	
111	*	
112	ASIN	
113	.06	WP Dist/1E3
114	*	
115	+	WP Fix
116	STO IND 10	
117	1	
118	ST+ 10	
119	RCL 12	L
120	ENTER↑	
121	X<> 04	WP Distance
122	XEQ 09	Leg Data
123	RCL 11	Update variation
124	STO 07	
125	"WP:"	
126	ARCL 06	WP Ident
127	ASTO IND 10	
128	GTO 21	
129	LBL 22	
130	CF 09	
131	1	
132	ST+ 10	
133	0	
134	STO IND 10	
135	1	
136	ST+ 10	
137	RCL 05	Leg Distance
138	RCL 04	WP Distance
139	XEQ 09	Leg Data
140	RCL 31	
141	STO 07	
142	RCL 32	Recall primary fix
143	STO 08	
144	RCL 33	
145	STO 09	
146	RCL 34	
147	STO 06	
148	GTO 20	
149	LBL 23	
150	CLX	
151	STO 34	
152	34	
153	FC?C 07	Not a WP?
154	XEQ 08	Terminal WP
155	CLX	
156	STO 01	
157	"DEPT EL?"	
158	PROMPT	
159	STO 19	
160	RCL 42	Leg #1 Altitude
161	INT	
162	ABS	
163	+	
164	2	
165	/	Average Climb altitude
166	XEQ 11	Wind Data
167	STO 20	Climb Wind
168	CLX	
169	STO 01	
170	"DEST EL?"	
171	PROMPT	
172	STO 21	
173	RCL 14	Last Altitude
174	+	
175	2	
176	/	Average Descent altitude
177	XEQ 11	Wind Data
178	STO 22	Descent Wind
179	RCL 35	
180	"T/FUEL="	
181	ARCL X	
182	"⊢?"	
183	PROMPT	
184	STO 35	
185	RCL 36	
186	"GW="	
187	ARCL X	
188	"⊢?"	
189	PROMPT	
190	STO 36	
191	"*LOAD AVFLY*"	
192	PROMPT	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

LBL'AVNAV
END 994 BYTES
TIMS 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
193	*LBL 01	Coordinate Input Subroutine
194	13	
195	FS? 08	
196	9	
197	*LBL 02	
198	STO 01	
199	*LBL 03	
200	AON	
201	PROMPT	
202	AOFF	
203	FC? 23	
204	RTN	
205	FC? 09	
206	CF 07	
207	ASTO 06	
208	16.03003	
209	STO 02	
210	STO 03	
211	XEQ 04	Search for Data
212	FS?C 05	Found?
213	RTN	
214	RCL 03	
215	STO 02	
216	SF 25	
217	AON	
218	RDTAX	Load Data
219	AOFF	
220	CF 25	
221	XEQ 05	Search for Data
222	FS?C 05	Found?
223	RTN	
224	CF 22	
225	CLA	
226	ARCL 06	
227	"⊢ LAT?"	
228	PROMPT	
229	CLA	Coordinate prompts
230	ARCL 06	
231	FC? 22	
232	GTO 06	
233	HR	
234	STO IND 01	
235	DSE 01	
236	CLA	
237	ARCL 06	
238	"⊢ LNG?"	
239	PROMPT	
240	HR	
241	STO IND 01	
242	DSE 01	
243	CLA	
244	ARCL 06	
245	"⊢ VAR?"	
246	PROMPT	
247	STO IND 01	
248	RTN	
249	*LBL 04	JBR?
250	RCL 06	
251	"JBR"	
252	ASTO Y	
253	CLA	
254	ARCL 06	
255	X≠Y?	
256	GTO 05	
257	10	
258	STO 02	
259	35.4952	
260	STO 11	
261	-903847.04	
262	STO 12	
263	GTO 00	
264	*LBL 05	Data search
265	RCL 06	
266	RCL IND 02	
267	X=Y?	
268	GTO 00	
269	ISG 02	
270	GTO 05	
271	RTN	
272	*LBL 00	Decoding Coordinate Data
273	SF 05	
274	1	
275	ST+ 02	
276	RCL IND 02	
277	HR	
278	STO IND 01	
279	DSE 01	
280	1	
281	ST+ 02	
282	RCL IND 02	
283	FRC	
284	LASTX	
285	INT	
286	ABS	
287	1 E4	
288	/	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
289	HR	
290	STO IND 01	
291	DSE 01	
292	RDN	
293	100	
294	*	
295	STO IND 01	
296	RTN	
297	♦LBL 06	Intersection Coordinates
298	FC? 09	WP?
299	FS? 06	Reference fix?
300	GTO 01	
301	RCL 07	
302	STO 11	
303	RCL 08	
304	STO 12	
305	RCL 09	
306	STO 13	
307	RCL 06	
308	STO 31	
309	SF 06	Reference fix flag
310	CF 23	
311	13	
312	"NEED FIX?"	
313	XEQ 02	Reference coordinates
314	CF 06	
315	RCL 31	
316	STO 06	
317	"FIX MC?"	
318	PROMPT	
319	CLA	
320	ARCL 06	
321	SF 23	
322	FC? 22	
323	GTO 01	
324	RCL 11	
325	FS? 08	
326	STO 07	
327	-	
328	STO 01	Ø
329	"FIX DIST?"	
330	PROMPT	
331	60	
332	/	d
333	SIN	
334	STO 02	Sin d
335	RCL 01	Ø
336	SIN	
337	*	
338	ASIN	
339	RCL 01	
340	COS	
341	RCL 02	
342	*	
343	ASIN	
344	RCL 13	
345	+	
346	STO 13	,LAT
347	FS? 08	
348	STO 09	
349	LASTX	
350	+	
351	2	
352	/	
353	COS	
354	/	
355	ST- 12	
356	RCL 12	LNG
357	FS? 08	
358	STO 08	
359	SF 07	
360	RTN	
361	♦LBL 07	TC & Distance Subroutine
362	RCL 13	
363	SIN	
364	RCL 09	
365	SIN	
366	*	Sin LAT Sin LAT'
367	STO 01	
368	RCL 13	
369	COS	
370	RCL 09	
371	COS	
372	*	Cos LAT Cos LAT'
373	STO 02	
374	+	
375	ACOS	
376	SIN	
377	RCL 13	
378	RCL 09	
379	-	+ Northerly
380	SIGN	- Southerly
381	*	
382	RCL 02	
383	RCL 12	
384	RCL 08	

LBL'AVNAV
END 994 BYTES
TIMS 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
385	-	- Westerly
386	X<0?	- Easterly
387	SF 05	
388	COS	
389	*	
390	RCL 01	
391	+	
392	ACOS	d
393	SIN	
394	STO 01	
395	LASTX	
396	60	
397	*	Distance
398	STO 02	
399	RDN	
400	/	
401	ASIN	α
402	FS? 05	
403	CHS	
404	90	
405	+	
406	180	
407	FS?C 05	
408	CLX	
409	+	∅
410	RTN	
411	*LBL 08	Terminal WP
412	STO 05	
413	CLA	
414	ARCL 06	
415	"⊢ WP?"	
416	SF 09	
417	CF 23	
418	XEQ 01	Coordinates
419	CF 09	
420	FC? 23	
421	RTN	
422	XEQ 07	$\emptyset^V$
423	180	
424	+	θ^V
425	RCL 11	VAR^V
426	+	
427	360	
428	MOD	
429	10	
430	*	
431	RND	
432	RCL 02	Distance
433	1 E3	
434	/	
435	+	Terminal WP Fix
436	STO IND 05	
437	DSE 05	
438	"WP:"	
439	ARCL 06	
440	ASTO IND 05	
441	RTN	
442	*LBL 09	.Leg Data Display
443	-	
444	1 E3	Distance/1E3
445	/	
446	RCL 00	∅
447	RND	
448	+	Crs.Dis
449	STO IND 10	
450	1	
451	ST+ 10	
452	"ALT="	
453	ARCL 14	
454	"⊢?"	
455	RCL 14	
456	CF 22	
457	PROMPT	
458	RND	
459	STO 14	
460	FS? 22	New Altitude?
461	SF 06	
462	RCL 07	VAR
463	1 E3	
464	/	
465	SIGN	
466	X<>Y	
467	LASTX	
468	ABS	
469	+	
470	*	Alt.Var
471	STO IND 10	
472	1	
473	ST+ 10	
474	*LBL 10	
475	CLX	
476	STO 01	
477	RCL 14	Altitude
478	XEQ 11	Wind
479	FS? 22	Wind entry?
480	GTO 00	

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LBL'AVNAV
END 994 BYTES
TIMS 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
481	43	
482	RCL 10	
483	X≠Y?	First Leg?
484	FS? 06	New Altitude?
485	GTO 10	
486	5	
487	-	
488	RCL IND X	Prior wind
489	*LBL 00	
490	STO IND 10	
491	1	
492	ST+ 10	
493	CF 06	
494	RTN	
495	*LBL 11	Wind Data
496	CF 22	
497	1 E3	
498	/	
499	30	
500	X<=Y?	Altitude above 30,000'?
501	GTO 12	
502	X<>Y	
503	12	
504	X<>Y	
505	X>Y?	Altitude above 12,000'?
506	SF 05	
507	3	
508	ENTER↑	
509	FC?C 05	
510	CLX	
511	+	
512	STO 02	Altitude increment
513	X>Y?	
514	GTO 12	
515	/	
516	FRC	
517	STO 03	Interpolation factor
518	X=0?	Altitude below 3,000'?
519	SF 05	
520	LASTX	
521	INT	
522	X=0?	Altitude same as forecast wind
523	1	
524	RCL 02	
525	*	
526	FS?C 05	
527	GTO 12	
528	ST+ 02	
529	XEQ 12	Lower Wind
530	FC? 22	
531	RTN	
532	STO 01	
533	RCL 02	
534	XEQ 12	Upper Wind
535	STO 02	
536	INT	
537	RCL 01	
538	INT	Interpolation of wind direction & velocity
539	-	
540	LASTX	
541	X<>Y	
542	1	
543	P-R	
544	R-P	
545	RDN	
546	RCL 03	
547	*	
548	+	
549	RND	
550	360	
551	MOD	
552	RCL 02	
553	FRC	
554	RCL 01	
555	FRC	
556	-	
557	LASTX	
558	X<>Y	
559	RCL 03	
560	*	
561	+	
562	+	
563	RTN	
564	*LBL 12	
565	"WA"	
566	ARCL X	
567	"⊢?"	
568	RCL 01	
569	PROMPT	
570	RCL 01	
571	X=Y?	
572	RTN	
573	X<>Y	Decode Wind Format
574	100	
575	/	
576	INT	
577	LASTX	
578	FRC	
579	10	
580	/	
581	X<>Y	
582	LASTX	
583	*	
584	+	
585	END	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

PROGRAM DESCRIPTION I

Program Title Aztec Flight Data (AVFLY)

Contributor's Name Robert A. Tims

Address

City **State/Country** **Zip Code**

Program Description, Equations, Variables This program utilizes the data generated by the AVHAV (*TIMS*) program to printout the flight data if the flight is made in a Piper Turbo Aztec.

The altitude and winds aloft of the first leg is used throughout the entire climbout, and of the final leg throughout the entire descent.

If the magnetic variation of the leg's ending fix is differant than that of the leg's beginning fix, both magnetic courses are displayed.

Wind Correction Formulas:

$$WCA = Sin^{-1}Y; \quad GS = TAS \ Cos \ WCA - W^V Sin \ \emptyset; \quad MH = TC + WCA + VAR$$

$$Y = r \ Sin \ \emptyset; \quad \emptyset = W^O - TC; \quad r = W^V/TAS$$

P-R Conversion: $Y = r \ Sin \ \emptyset$, $X = r \ Cox \ \emptyset$ then -

$$GS = TAS(Cos \ WCA - X) = TAS(Cos \ WCA) - W^V \ Cos \ \emptyset$$

Formulas in pure aviation terms:

$$WCA = Sin^{-1}(W^V Sin(W^O - TC)/TAS)$$

$$GS = TAS \ Cos \ WCA - W^V \ Cos(W^O - TC)$$

Necessary Accessories Printer

Operating Limits and Warnings Data error will be displayed if a level altitude isn't established prior to the final descent or if not enough time to climb to initial altitude prior to descent. TAS must not equal zero.

PROGRAM DESCRIPTION II

Sample Problem (Sketch if Desired)

Output from the AVNAV program.

SOLUTION:

```
XEQ "AZFLY"

PBF TO JBR
T/DIST 118 NM

PBF * WP:PBF
182.2°, 4.4 NM

PBF to WP:LIT
MC=032°/031°
DIST=17 NM

WP:LIT
121.1°, 27.6 NM

CLIMB 206 → 3500
HDG=037°
TAS=115
GS=119
DIST=7
REM DIST=111
TIME=0:03:44

LEVEL AT 3500
HDG=036°
TAS=174
GS=179
DIST=10
REM DIST=101
TIME=0:03:21
T/TIME=0:07:05

WP:LIT to HILLE
MC=031°/032°
DIST=53 NM

CLIMB 3500 → 7500
HDG=037°
TAS=115
GS=126
DIST=9
REM DIST=92
TIME=0:04:30
T/TIME=0:11:35

LEVEL AT 7500
HDG=034°
TAS=180
GS=197
DIST=44
REM DIST=48
TIME=0:13:26
T/TIME=0:25:01

HILLE to JBR
MC=023°
DIST=48 NM

LEVEL AT 7500
HDG=020°
TAS=180
GS=199
DIST=23
REM DIST=25
TIME=0:06:55
T/TIME=0:31:56

DESCENT 7500 → 262
HDG=024°
TAS=195
GS=207
DIST=25
TIME=0:07:14
T/TIME=0:39:10

JBR * WP:G0E
340.2°, 30.2 NM

LANDING WT= 4949 LBS
REM FUEL=94 GAL
RESERVE TIME=2:46:22

HAPPY FLYING
```

LBL'AZFLY
TIMS

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS

00	1E3
01	Distance
02	Ground speed
03	Time
04	Magnetic heading
05	Crs.Dis
06	Variation
07	True Airspeed
08	Leg Distance
09	Total Flyine Time
10	Leg Pointer
11	Scratch
12	Scratch
13	Present Altitude
14	Previous Altitude
15	Total Distance
16	Last Register (39 + 5N)
17	Previous Wind
18	Present Wind
19	Departure Elev.
20	Climb Wind
21	Destination Elev.
22	Descent Wind
23	Last level altitude
24	Remaining Fuel
25	Landing Weight
26	Descending Alt.
27	Re maining Dist
28	not used
29	not used
30	not used
31	Destination VAR
32	Descent Point
33	Dest. WP Ident
34	Dest. WP Fix
35	Total Fuel
36	Takeoff Weight
37	Depart. WP Ident
38	Depart. WP Fix
39	Leg #1 Ident
40	WP Fix
41	Crs.Dis
42	Alt.Var
43	Wind data
44	Leg #2

-etc.-

(39+5N), N is the number of legs

STATUS

SIZE 40+5N TOT. REG. 156 + USER MODE

ENG ____ FIX ____ SCI ____ ON X OFF

DEG X RAD ____ GRAD ____

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
05	C	Climbout	
06	C	Descent in 1st leg Climbing Descent continued	
07	C	Descent Point Leg	
08	C	Last leg	

ASSIGNMENTS

FUNCTION	KEY	FUNCTION	KEY
XEQ "AZFLY"	24 (TAN)		

LBL'AZFLY
END 1090 BYTES
TIMS 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
01	*LBL "AZFLY"	
02	CF 07	Initialize
03	CF 08	
04	CF 29	
05	"*PRINTER*"	
06	FC? 55	
07	PROMPT	
08	FIX 0	
09	RCL 10	
10	STO 16	
11	RCL 15	
12	STO 27	
13	RCL 35	
14	STO 24	
15	RCL 36	
16	STO 25	
17	0	
18	STO 06	
19	STO 09	
20	STO 18	
21	2.96295	
22	ST- 10	
23	RCL 14	Last altitude
24	STO 23	
25	RCL 21	Destination elevation
26	STO 13	
27	-	
28	1 E3	
29	STO 00	ROD
30	/	
31	60	
32	/	
33	STO 11	Time to descend
34	195	Descent TAS
35	STO 07	
36	*LBL 15	
37	RCL 13	Leg's lowest altitude
38	STO 26	
39	RCL IND 10	
40	STO 05	Leg Crs.Dis
41	SF 06	
42	DSE 10	SF 06 if Leg#1
43	CF 06	
44	RCL 22	Descent wind
45	XEQ 03	Wind Correction
46	RCL 11	
47	X<=Y?	Enough time for descent?
48	GTO 00	
49	X<>Y	
50	ST- 11	Descent time used
51	60	
52	*	
53	RCL 00	ROD
54	*	
55	ST+ 13	Leg's highest altitude
56	CLX	
57	FS? 06	Error trap: not enough
58	LN	time.
59	RCL 10	
60	6	
61	+	
62	RCL IND X	
63	SIGN	
64	LASTX	
65	FRC	Present VAR
66	ABS	
67	RCL 21	
68	RND	
69	+	
70	*	
71	STO IND Y	Low Alt.Var
72	GTO 15	
73	*LBL 00	
74	RCL 02	Ground Speed
75	*	
76	RCL 00	
77	/	
78	STO 32	Descent point
79	RCL 10	
80	6	
81	+	
82	RCL IND X	
83	SIGN	
84	LASTX	
85	FRC	Present VAR
86	ABS	
87	RCL 14	Last altitude
88	+	
89	*	Last leg Alt.Var
90	STO IND Y	
91	ADV	
92	CLA	
93	SF 12	
94	ARCL 39	
95	"-> TO "	Preface
96	ARCL IND 16	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

LBL'AZFLY
END 1090 BYTES
TIMS 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
97	AVIEW	
98	CF 12	
99	"T/DIST "	
100	ARCL 15	
101	"⊢ NM"	
102	PRA	
103	ADV	
104	CLA	
105	ARCL 39	
106	"⊢ * "	
107	ARCL 37	
108	RCL 38	
109	X≠0?	Terminal WP?
110	XEQ 06	WP Display
111	RCL 19	Departure elevation
112	STO 13	
113	SF 05	Climbout Flag
114	RCL 10	
115	INT	
116	2	
117	+	
118	RCL 00	
119	/	
120	39	
121	FS?C 06	
122	GTO 21	
123	+	
124	STO 10	Leg pointer
125	*LBL 20	
126	ADV	
127	CLA	
128	ARCL IND 10	
129	ISG 10	
130	ACA	
131	CLA	Leg preface
132	SF 13	
133	" TO "	
134	ACA	
135	CF 13	
136	CLA	
137	RCL 10	
138	4	
139	+	
140	STO 01	
141	ARCL IND X	
142	ACA	
143	PRBUF	
144	RCL IND 10	
145	ISG 10	
146	STO 11	
147	"MC="	
148	RCL IND 10	
149	ISG 10	
150	STO 05	Crs.Dis
151	INT	TC
152	RCL IND 10	
153	FRC	
154	RCL 00	
155	*	
156	STO 06	VAR
157	+	MC
158	STO 12	
159	XEQ 10	Degree format
160	RCL 16	
161	RCL 10	
162	5	
163	+	
164	X>Y?	Last Leg?
165	SF 08	
166	X<Y?	
167	RCL IND X	
168	FRC	Next VAR
169	RCL 00	
170	*	
171	FS?C 08	Last leg?
172	RCL 31	Last VAR
173	RCL 05	
174	INT	TC
175	+	Next MC
176	RCL 12	MC
177	X<>Y	
178	"/"	
179	X≠Y?	Differant?
180	XEQ 10	Degree format
181	PRBUF	
182	"DIST="	
183	RCL 05	
184	FRC	
185	RCL 00	
186	*	Leg Distance
187	STO 08	
188	ARCL X	
189	"⊢ NM"	
190	PRA	
191	CLA	
192	ARCL IND 01	Ending fix

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
193	RCL 11	
194	X≠0?	Waypoint?
195	XEQ 06	Display WP
196	ADV	
197	RCL 18	Present wind and altitude
198	STO 17	become the previous
199	RCL 13	wind and altitude.
200	STO 14	
201	FS? 05	Climbout?
202	FC? 07	Descent leg?
203	GTO 00	
204	RCL 42	Error trap: Climb & Descent
205	INT	altitudes must equal if
206	RCL IND 10	they occur in the same
207	INT	leg.
208	X≠Y?	
209	CLX	
210	/	
211	*LBL 00	
212	RCL 42	
213	FC? 05	
214	RCL IND 10	Alt.Var
215	ISG 10	
216	INT	
217	ABS	
218	STO 13	Present altitude
219	RCL IND 10	
220	STO 18	Present wind
221	X<>Y	
222	RCL 14	Previous altitude
223	FS?C 06	
224	RTN	
225	X≠Y?	Altitude change?
226	XEQ 04	Climb/Descend
227	RCL 05	
228	FRC	Dis/1E3
229	FC? 07	
230	GTO 00	
231	RCL 32	Descent point
232	X>Y?	Enough time?
233	CF 07	
234	RCL 05	
235	INT	TC
236	X<>Y	
237	+	Crs.DP
238	STO 32	
239	LASTX	
240	FIX 3	
241	RND	
242	ST- 05	Distance remainder
243	FIX 0	
244	CLX	
245	FC? 07	Error trap: not enough
246	LN	time for descent
247	GTO 01	
248	*LBL 00	
249	X=0?	Leg distance flown?
250	GTO 02	
251	*LBL 01	
252	5280	
253	RCL 36	
254	-	
255	.005	
256	*	
257	LASTX	
258	.3	
259	*	
260	RCL 13	
261	*	
262	+	
263	168	
264	+	
265	STO 07	Cruise TAS
266	RCL IND 10	Wind
267	FS?C 05	
268	RCL 43	
269	XEQ 03	Wind correction
270	34	Cruise F/F
271	*	
272	STO 11	
273	"LEVEL AT "	
274	ARCL 13	
275	PRA	
276	XEQ 07	Display data
277	FS?C 07	
278	RTN	
279	*LBL 02	
280	ISG 10	
281	GTO 20	
282	RCL 10	Present leg
283	INT	
284	*LBL 21	
285	RCL 16	
286	1	
287	-	
288	RCL 00	

LBL'AZFLY
END 1090 BYTES
TIMS 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
289	/	
290	+	
291	STO 10	Leg pointer
292	SF 07	Descent leg flag
293	XEQ 20	
294	195	Descent TAS
295	STO 07	
296	RCL 13	Highest altitude
297	STO 14	
298	RCL 26	Lowest altitude
299	STO 13	
300	RCL 32	
301	STO 05	
302	GTO 23	
303	*LBL 03	Wind Correction Subroutine
304	FRC	$W^V/1E3$
305	LASTX	
306	INT	W^O
307	RCL 05	
308	INT	TC
309	-	θ
310	X<>Y	
311	RCL 00	
312	*	W^V
313	RCL 07	TAS
314	/	r
315	P-R	r Cos θ
316	RDN	r Sin θ
317	ASIN	WCA
318	COS	
319	R↑	r Cos θ
320	LASTX	WCA
321	RCL 05	
322	INT	TC
323	+	
324	RCL 06	VAR
325	+	
326	STO 04	MH
327	RDN	Cos WCA
328	-	Cos WCA - X
329	RCL 07	TAS
330	*	
331	STO 02	GS
332	RCL 05	
333	FRC	
334	RCL 00	
335	*	
336	STO 01	Distance
337	RCL 02	
338	/	
339	STO 03	Time
340	RTN	
341	*LBL 04	Climb/Descend subroutine
342	-	Altitude change
343	STO 11	
344	X>0?	Climb?
345	SF 06	
346	45 E5	
347	RCL 25	
348	/	
349	FC? 06	
350	R↓ 08	
351	STO 12	
352	195	Descent TAS
353	FS? 06	
354	115	Climb TAS
355	STO 07	
356	RCL 20	Climb Wind
357	FS? 05	Climb?
358	GTO 00	
359	RCL 18	Present wind
360	INT	
361	RCL 17	Previous wind
362	INT	
363	-	
364	LASTX	
365	X<>Y	
366	1	
367	P-R	Calculate average W^O
368	R-P	
369	RDN	
370	2	
371	/	
372	+	
373	RND	
374	RCL 18	
375	FRC	
376	RCL 17	
377	FRC	Calculate average W^V
378	-	
379	LASTX	
380	X<>Y	
381	2	
382	/	
383	+	
384	+	Average Wind

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

LBL'AZFLY
END 1090 BYTES
TIMS 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
385	*LBL 00	
386	XEQ 03	Wind correction
387	RCL 11	Altitude change
388	ABS	
389	RCL 12	Vertical speed
390	/	
391	60	
392	/	Total time needed
393	X>Y?	Not enough time?
394	GTO 00	
395	STO 03	Climb/Descend time
396	RCL 02	Ground speed
397	*	
398	RND	
399	STO 01	Climb/Descend distance
400	RCL 00	
401	/	Dist/1E3
402	GTO 01	
403	*LBL 00	
404	X<>Y	Available time
405	60	
406	*	
407	RCL 12	Vertical speed
408	*	
409	FC? 06	Descent?
410	CHS	
411	RCL 14	Starting altitude
412	+	
413	STO 13	Ending altitude
414	RCL 05	
415	FRC	Dist/1E3
416	*LBL 01	
417	ST- 05	
418	24	Descent F/F
419	FS? 06	
420	54	Climb F/F
421	RCL 03	Time
422	*	
423	STO 11	Fuel used
424	"CLIMB"	
425	*LBL 05	Descent display
426	FC?C 06	
427	"DESCENT"	
428	ACA	
429	RCL 14	
430	ACX	
431	1	
432	SKPCHR	
433	125	
434	ACCHR	
435	RCL 13	
436	ACX	
437	PRBUF	
438	GTO 07	Display data
439	*LBL 06	WP Display Subroutine
440	ADV	
441	PRA	
442	CLA	
443	STO 12	
444	FIX 1	
445	INT	
446	10	
447	/	
448	XEQ 10	
449	", "	
450	RCL 12	
451	FRC	
452	RCL 00	
453	*	
454	ARCL X	
455	"⊢ NM"	
456	ACA	
457	PRBUF	
458	FIX 0	
459	RTN	
460	*LBL 07	Display
461	RCL 11	
462	ST- 24	Subtract fuel used
463	6	
464	*	
465	ST- 25	GW - Fuel used
466	"HDG="	
467	RCL 04	
468	XEQ 10	Degree format
469	PRBUF	
470	"TAS="	
471	ARCL 07	
472	PRA	
473	"GS="	
474	ARCL 02	
475	PRA	
476	"DIST="	
477	ARCL 01	
478	RCL 08	Leg distance
479	RCL 01	distance
480	RND	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

LBL'AZFLY
END 1090 BYTES
TIMS 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
481	X≠Y?	
482	PRA	
483	ST- 27	
484	"REM DIST="	
485	ARCL 27	
486	RCL 27	
487	X>0?	Distance left?
488	PRA	
489	FIX 4	
490	RCL 03	Time
491	HMS	
492	RND	
493	HR	
494	STO 03	
495	ST+ 09	
496	FIX 0	
497	CLA	
498	XEQ 08	
499	"T/"	
500	RCL 03	
501	RCL 09	
502	X≠Y?	
503	XEQ 08	Time display
504	ADV	
505	RTN	
506	*LBL 08	Time Display
507	HMS	
508	INT	
509	"⊢TIME="	
510	ARCL X	
511	10	
512	XEQ 09	
513	X<>Y	
514	XEQ 09	
515	PRA	
516	RTN	
517	*LBL 09	Time Format
518	"⊢:"	
519	LASTX	
520	FRC	
521	100	
522	*	
523	X<Y?	
524	"⊢0"	
525	INT	
526	ARCL X	
527	RTN	
528	*LBL 10	Degree Format
529	360	
530	MOD	
531	X≠0?	
532	GTO 00	
533	LASTX	
534	+	
535	*LBL 00	
536	100	
537	X>Y?	
538	"⊢0"	
539	SQRT	
540	X>Y?	
541	"⊢0"	
542	ARCL Y	
543	ACA	
544	0	
545	ENTER↑	Degree
546	BLDSPEC	Character
547	6	
548	BLDSPEC	
549	9	
550	BLDSPEC	
551	9	
552	BLDSPEC	
553	9	
554	BLDSPEC	
555	6	
556	BLDSPEC	
557	ACSPEC	
558	RTN	
559	*LBL 22	Descent continues
560	SF 06	
561	XEQ 20	
562	*LBL 23	
563	RCL 22	Descent wind
564	XEQ 03	Wind correction
565	24	Descent F/F
566	*	
567	STO 11	Fuel used
568	XEQ 05	Descent display
569	ISG 10	
570	GTO 22	
571	CLA	
572	ARCL IND 16	
573	"⊢ * "	
574	ARCL 33	
575	RCL 34	
576	X≠0?	Terminal WP?
577	XEQ 06	Display WP
578	ADV	
579	RCL 25	Rem. Wt.
580	"LANDING WT= "	
581	ARCL X	
582	"⊢ LBS"	
583	PRA	
584	RCL 24	Rem. fuel
585	RND	
586	"REM FUEL="	
587	ARCL X	
588	"⊢ GAL"	
589	X>0?	Fuel left?
590	PRA	
591	LASTX	
592	34	Cruise F/F
593	/	
594	X<0?	
595	CLX	
596	STO 12	
597	"RESERVE "	
598	XEQ 08	Time Display
599	ADV	
600	"HAPPY FLYING"	
601	SF 12	
602	RCL 12	Fuel time
603	.75	
604	X>Y?	
605	"FUEL TOO LOW"	
606	BEEP	
607	AVIEW	
608	CF 12	
609	RCL 16	Initialize
610	STO 10	for
611	RCL 23	reprint
612	STO 14	
613	ADV	
614	END	

PROGRAM DESCRIPTION I

Program Title Data Record

Contributor's Name

Address

City State/Country Zip Code

Program Description, Equations, Variables This program prompts for navigation fix data, encodes it, and writes it on a magnetic card. The recorded data includes the facility identifier, latitude & longitude coordinates, and the magnetic variation. Each facility takes 3 data registers, so a total of five facilities may be recorded on each track. The data, after it is input may be reviewed for correctness and changed if needed. After the data is input and after it has been viewed, the program prompts to write it on a card. If a card track is loaded by simply inserting it into the card reader, that data will can be viewed. Anytime the program prompts for the ident, if input is declined, the program will proceed to view the contents.

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS	STATUS
00 to 14 Facility data 15 Counter value 16 Identifier	SIZE 17 TOT. REG. USER MODE ENG FIX SCI ON OFF DEG X RAD GRAD

Necessary Accessories

Operating Limits and Warnings If the viewing is terminated while viewing the variation the variation data will be lost from that data register. This isn't important as the data will already have been recorded, unless"DR"is being used in a master program. Terminating the viewing anywhere else will not change the data in the registers.

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
01	♦LBL "DR"	
02	.014	Counter value
03	STO 15	
04	♦LBL 01	
05	CF 23	
06	"IDENT?"	
07	AON	
08	PROMPT	
09	AOFF	
10	FC?C 23	Input declined?
11	GTO 03	start viewing data
12	ASTO 16	Store Ident
13	ASTO IND 15	
14	ISG 15	
15	CLA	
16	ARCL 16	
17	"⊢ LAT?"	
18	PROMPT	
19	STO IND 15	
20	ISG 15	
21	CLA	
22	ARCL 16	
23	"⊢ LNG?"	
24	PROMPT	
25	1 E4	
26	*	
27	CLA	
28	ARCL 16	
29	"⊢ VAR?"	Code LNG.VAR
30	PROMPT	
31	SIGN	
32	X<>Y	
33	LASTX	
34	ABS	
35	100	
36	/	
37	+	
38	*	
39	STO IND 15	
40	ISG 15	
41	GTO 01	
42	♦LBL 02	
43	.014	
44	STO 15	
45	WDTAX	Write data card
46	♦LBL 03	
47	CLA	
48	AON	
49	ARCL IND 15	
50	PROMPT	View Identifier/
51	AOFF	correct & store
52	ASTO 16	
53	ASTO IND 15	
54	ISG 15	
55	FIX 4	
56	RCL IND 15	
57	CLA	
58	ARCL 16	
59	"⊢="	
60	ARCL X	
61	PROMPT	View Lat/ correct
62	STO IND 15	& store
63	ISG 15	
64	RCL IND 15	
65	INT	
66	ABS	
67	1 E4	
68	/	
69	CLA	
70	ARCL 16	
71	"⊢="	
72	ARCL X	
73	PROMPT	View Lng/ correct
74	1 E4	& store
75	*	
76	X<> IND 15	
77	FIX 1	
78	FRC	
79	100	
80	*	
81	CLA	
82	ARCL 16	
83	"⊢="	
84	ARCL X	
85	PROMPT	View Var/ correct
86	100	& store
87	/	
88	ABS	
89	ST+ IND 15	
90	LASTX	
91	SIGN	
92	ST* IND 15	
93	ISG 15	
94	GTO 03	
95	GTO 02	Write data card
96	END	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

PROGRAM DESCRIPTION

Program Title Weight and Balance, AZTEC 62773

Contributor's Name Robert A. Tims

Address

City **State/Country** **Zip Code**

Program Description, Equations, Variables This program computes the center of gravity for the Aztec, N62773 and sums up the gross weight. It outputs if weight is over gross and if over zero fuel weight. It calculates the forward CG limit and displays both the forward and aft limits prior to output of the center of gravity.

The forward CG is calculated according to the following formulas:

$3600 \leq GW \leq 4600$ -

$$FWD\ CG = -85.23 + 21.1\ Ln(GW)$$

$4600 < GW < 5000$ -

$$FWD\ CG = -211.06 + 36\ Ln(GW)$$

$5000 \leq GW \leq 5200$ -

$$FWD\ CG = -642.62 + 86.67\ Ln(GW)$$

```
AZTEC N62773

PILOTS=  175
ROW 1=   410
ROW 2=   150
FWD BAG=   0
AFT BAG=  35
MAX FUEL=136
INBD FUEL= 68
OUTBD FUEL= 50
T/FUEL= 118
CG LIMITS: 97.1 100.5
CG= 98.7
GW= 5091 LBS

          VIEW 35
             118
          VIEW 36
            5091
```

Necessary Accessories Printer is recommended

Operating Limits and Warnings When input is declined, 0 is entered.

Fuel must be entered in gallons.

LBL'WBAZ
TIMS

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS

00	Pilots seat moment arm
01	Row 1 seat moment arm
02	Row 2 seat moment arm
03	FWD baggage moment arm
04	AFT baggage moment arm
05	Inboard fuel moment arm
06	Outboard fuel moment arm
07	Tip fuel moment arm correction
08	Weight sum
09	Moment sum, CG
11	pointer
35	T/Fuel in gal
36	Gross weight

STATUS

SIZE	37	TOT. REG.	101	USER MODE	
ENG		FIX	SCI	ON	X OFF
DEG		RAD	GRAD		

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
22	S		ROW 2 empty
55		Printer exsists	

ASSIGNMENTS

FUNCTION	KEY	FUNCTION	KEY
XEQ "WBAZ"	-25 (TAN)		

LBL'WBAZ
END 473 BYTES
TIMS ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
01	*LBL "WBAZ"	
02	ADV	
03	SF 22	
04	FIX 0	
05	CF 29	
06	"AZTEC N62773"	
07	SF 12	
08	AVIEW	
09	CF 12	
10	SF 21	
11	ADV	
12	89	
13	STO 00	Store arm moments
14	126	
15	STO 01	
16	157	
17	STO 02	
18	10	
19	STO 03	
20	183	
21	STO 04	
22	113	
23	STO 05	
24	STO 06	
25	-6.3	Tip tank correction
26	STO 07	
27	CLX	
28	STO 08	
29	STO 09	
30	STO 11	
31	STO 35	
32	"PILOTS"	
33	XEQ 06	
34	"ROW 1"	
35	XEQ 06	
36	"ROW 2"	
37	CF 22	
38	XEQ 06	
39	"FWD BAG"	
40	XEQ 06	
41	"AFT BAG"	
42	XEQ 06	
43	RCL 08	
44	943	
45	X<Y?	Over zero fuel weight?
46	XEQ 11	
47	177	Fuel tank capacity
48	1587	Useful load
49	RCL 08	
50	-	
51	6	
52	/	
53	"MAX FUEL="	
54	ARCL X	
55	X<Y?	
56	AVIEW	
57	CLX	
58	"INBD FUEL="	
59	XEQ 05	
60	"OUTBD FUEL="	
61	XEQ 05	
62	"T/FUEL= "	
63	ARCL 35	
64	AVIEW	
65	RDN	
66	411.6	
67	-	
68	X>0?	Tip tanks used?
69	XEQ 08	
70	3613	Empty Weight
71	ST+ 08	
72	90	Empty CG
73	*	
74	RCL 09	
75	+	
76	RCL 08	
77	/	
78	STO 09	CG
79	4600	
80	RCL 08	
81	X<=Y?	FWD CG Calculations:
82	GTO 02	
83	5 E3	
84	X>Y?	
85	GTO 03	
86	X<>Y	
87	LN	
88	86.67	5000# or over
89	*	
90	642.62	
91	GTO 04	
92	*LBL 02	
93	LN	
94	21.1	3600# to 4600#
95	*	
96	85.23	
97	GTO 04	
98	*LBL 03	Between 4600# and 5000#

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

LBL"WBAZ
END 473 BYTES
TIMS ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
99	X<>Y	
100	LN	
101	36	
102	*	
103	211.06	
104	*LBL 04	
105	-	
106	FIX 1	
107	"CG LIMITS:"	
108	FS? 55	
109	GTO 00	
110	AVIEW	Ouput CG limits
111	CLA	
112	ARCL X	
113	"⊢ 100.5"	
114	AVIEW	
115	GTO 01	
116	*LBL 00	
117	ACA	
118	ACX	
119	*LBL 01	
120	RCL 09	
121	CLA	
122	X<Y?	
123	"FWD "	
124	100.5	FWD or AFT CG?
125	FS? 55	
126	ACX	
127	X<Y?	
128	"AFT "	
129	"⊢CG= "	
130	ARCL Y	
131	AVIEW	
132	GTO 13	
133	*LBL 05	
134	PROMPT	
135	ST+ 35	
136	FS? 55	
137	XEQ 12	
138	6	
139	*	Fuel weight
140	GTO 07	
141	*LBL 06	
142	"⊢= "	
143	PROMPT	
144	FS? 55	
145	XEQ 12	
146	FC? 22	Row 2 empty?
147	GTO 10	
148	*LBL 07	
149	ST+ 08	
150	*LBL 08	Moment calculation
151	RCL IND 11	
152	X<>Y	
153	*	
154	ST+ 09	
155	LASTX	
156	*LBL 09	
157	1	
158	ST+ 11	
159	CLX	
160	RTN	
161	*LBL 10	Slide Row 1 back 6"
162	SF 22	
163	RDN	
164	132	
165	*	
166	ST+ 09	
167	X<>Y	
168	ST- 09	
169	GTO 09	
170	*LBL 11	Overweight output
171	-	
172	"OVER WT"	
173	FS? 55	
174	GTO 12	
175	"⊢ "	
176	ARCL X	
177	AVIEW	
178	RTN	
179	*LBL 12	
180	ACA	
181	ACX	
182	PRBUF	
183	RTN	
184	*LBL 13	
185	FIX 0	
186	"GW= "	
187	ARCL 08	
188	"⊢ LBS"	
189	AVIEW	
190	RCL 08	
191	STO 36	
192	5200	
193	X<Y?	Overgross?
194	XEQ 11	
195	END	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

LBL"R
LBL"V
END
TIMS

92 BYTES

PROGRAM DESCRIPTION I

Program Title Groundspeed along MC

Contributor's Name Robert A. Tims

Address

City **State/Country** **Zip Code**

Program Description, Equations, Variables Computes the groundspeed using DME and waypoint data or MC and Omni Bearing data. LBL "R" uses DME and waypoint distance and LBL "V" uses MC and Bearing to or from the VOR. Both methods use the tangential speed readout from the DME.

Necessary Accessories NONE

Operating Limits and Warnings Not very accurate when the bearing from the VOR is perpendicular to the MC or if the aircraft is within 10NM of the waypoint.

LBL'R
LBL'V
END 92 BYTES
TIMS

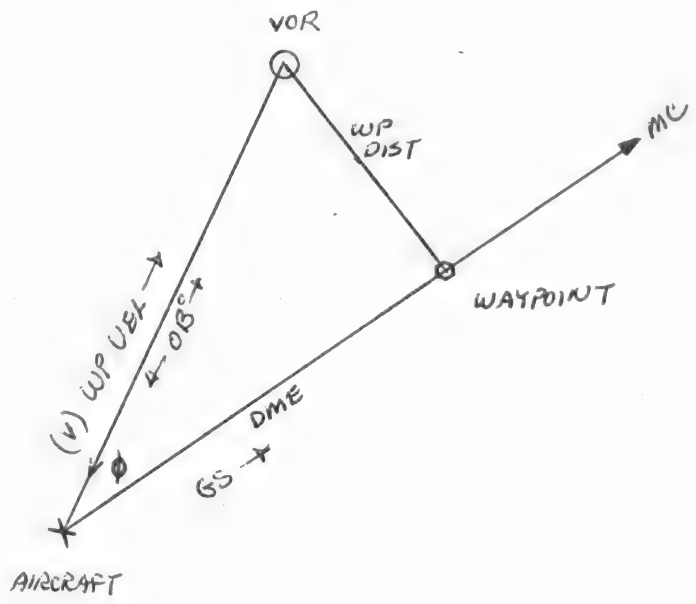
FIX 2 ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
01	*LBL "R"	
02	1	
03	STO 00	
04	"WP DIST?"	
05	PROMPT	
06	STO 01	
07	*LBL 01	
08	RCL 01	
09	"DME?"	
10	PROMPT	
11	/	
12	X↑2	
13	1	
14	+	
15	SQRT	
16	GTO 00	
17	*LBL "V"	
18	2	
19	STO 00	
20	"MC?"	
21	PROMPT	
22	STO 01	
23	*LBL 02	
24	RCL 01	
25	"OB?"	
26	PROMPT	
27	-	
28	1	
29	P-R	
30	R-P	
31	RDN	
32	COS	
33	1/X	
34	ABS	
35	*LBL 00	
36	"WP VEL?"	
37	PROMPT	
38	*	
39	FIX 0	
40	CF 29	
41	"GS="	
42	ARCL X	
43	"KNM"	
44	PROMPT	
45	GTO IND 00	
46	END	

$$V \sec\phi = V\sqrt{1+\tan^2\phi} = V\sqrt{1+\left(\frac{WP\ DIST}{DME}\right)^2}$$

$$= \left|\frac{V}{\cos\phi}\right|$$



Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

PROGRAM DESCRIPTION I

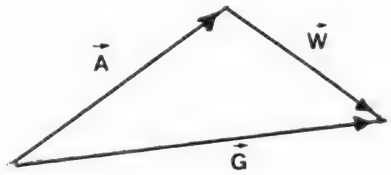
Program Title IN-FLIGHT WINDS | HEADWINDS AND CROSSWINDS

This program is actually in two parts: one to determine in-flight winds, and the other to resolve a wind into its headwind or tailwind and right or left crosswind components.

Determining In-Flight Winds

This program computes the winds at altitude from TAS, course of aircraft, ground speed and heading. Ground speed is automatically calculated from time-distance inputs. Winds can be computed as either magnetic or true. The latter must be used when verifying wind forecasts by the weather bureau. The program allows continuous updating of winds.

This program solves the wind triangle shown below.



OR $\vec{A} + \vec{W} = \vec{G}$

$\vec{W} = \vec{G} - \vec{A}$

W, **A** and **G** are all vector quantities representing wind direction and speed; TAS and heading; and ground speed and course respectively.

Since both **A** and **G** use magnetic directions, **W** is computed as a magnetic direction. It must be corrected to true heading by adding the variation V.

True wind direction = magnetic wind direction ➡ magnetic variation

Headwinds and Crosswinds

Also, this program calculates both the head wind and cross wind components from the aircraft heading and reported winds. The program works both at altitude, where magnetic variation must be considered, and at landing and takeoff, where winds are reported in magnetic directions rather than true directions.

HW= Head Wind
RCW= RightCross Wind
TW= Tail Wind
LCW= Left Cross Wind

The head wind (HW) and right cross wind (RCW) components are computed from

$HW = K \cos (D - HDG + V)$

$RCW = K \sin (D - HDG + V)$

where

K = the reported wind velocity

D = the reported wind direction

HDG = the aircraft heading

V = the magnetic variation (+ west, ➡ east)

Necessary Accessories

Operating Limits and Warnings

Wind directions reported by the control tower are magnetic and the variation need not be input when using the program for takeoff and landings. Other wind directions are reported in true directions and variation must be included to find the wind components.

LBL'IFW
LBL'HCW
END 387 BYTES
TIMS

PROGRAM LISTING

■ 41C

STEP/ LINE	KEY ENTRY	COMMENTS
01	♦LBL "IFW"	
02	CF 05	
03	♦LBL 01	
04	CF 29	
05	FIX 1	
06	ADV	
07	RCL 06	
08	"VAR="	
09	XEQ 03	
10	STO 06	
11	FC? 55	
12	GTO 00	
13	CLA	
14	ARCL X	
15	XEQ 07	
16	♦LBL 00	
17	FIX 0	
18	RCL 04	
19	"MH="	
20	XEQ 04	
21	STO 04	
22	FS? 55	
23	XEQ 05	
24	FS?C 05	
25	RTN	
26	RCL 05	
27	"MC="	
28	XEQ 04	
29	STO 05	
30	FS? 55	
31	XEQ 05	
32	RCL 07	
33	"TAS="	
34	XEQ 03	
35	STO 07	
36	FS? 55	
37	XEQ 08	
38	RCL 02	
39	"GS="	
40	XEQ 03	
41	STO 02	
42	FS? 55	
43	XEQ 08	
44	RCL 04	
45	RCL 07	
46	P-R	
47	RCL 05	
48	RCL 02	
49	P-R	
50	X<>Y	
51	ST- T	
52	RDN	
53	-	
54	R-P	
55	RND	
56	STO 12	
57	X<>Y	
58	RCL 06	
59	-	
60	RND	
61	STO 11	
62	SF 21	
63	ADV	
64	"WIND DIR="	
65	XEQ 06	
66	FC? 55	
67	AVIEW	
68	"WIND VEL="	
69	ARCL 12	
70	FS? 55	
71	GTO 09	
72	CF 21	
73	AVIEW	
74	RTN	
75	GTO 01	
76	♦LBL "HCW"	
77	♦LBL 02	
78	SF 05	
79	XEQ 01	
80	RCL 11	
81	"WIND DIR="	
82	XEQ 04	
83	STO 11	
84	FS? 55	
85	XEQ 05	
86	RCL 12	
87	"WIND VEL="	
88	XEQ 03	
89	STO 12	
90	FS? 55	
91	XEQ 08	
92	ADV	
93	RCL 11	
94	RCL 04	
95	-	
96	RCL 06	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

LBL'IFW
LBL'HCW
END 387 BYTES
TIMS

PROGRAM LISTING

■ 41C

STEP/ LINE	KEY ENTRY	COMMENTS
97	+	
98	RCL 12	
99	P-R	
100	"HW="	
101	X<0?	
102	"TW="	
103	ASTO 00	
104	ABS	
105	RND	
106	X<>Y	
107	"R"	
108	X<0?	
109	"L"	
110	"┣CW="	
111	ABS	
112	ARCL X	
113	FC? 55	
114	"┣ "	
115	FS? 55	
116	XEQ 09	
117	ARCL 00	
118	ARCL Y	
119	FS? 55	
120	XEQ 09	
121	CF 21	
122	AVIEW	
123	SF 21	
124	RTN	
125	GTO 02	
126♦	LBL 03	
127	FS? 55	
128	ACA	
129	ARCL X	
130	"┣?"	
131	PROMPT	
132	RND	
133	RTN	
134♦	LBL 04	
135	FS? 55	
136	ACA	
137	CF 21	
138	XEQ 06	
139	SF 21	
140	"┣?"	
141	RDN	
142	PROMPT	
143	RND	
144	RTN	
145♦	LBL 05	
146	CLA	
147♦	LBL 06	
148	360	
149	MOD	
150	X≠0?	
151	GTO 00	
152	LASTX	
153	+	
154♦	LBL 00	
155	100	
156	X>Y?	
157	"┣0"	
158	SQRT	
159	X>Y?	
160	"┣0"	
161	ARCL Y	
162	FS? 21	
163	FC? 55	
164	RTN	
165♦	LBL 07	
166	ACA	
167	0	
168	ENTER↑	VAR=-7.5°
169	BLDSPEC	MH=165°
170	6	MC=150°
171	BLDSPEC	TAS=110kts
172	9	GS=120kts
173	BLDSPEC	
174	9	WIND DIR=273°
175	BLDSPEC	WIND VEL=32kts
176	9	
177	BLDSPEC	VAR=-7.5°
178	6	MH=165°
179	BLDSPEC	WIND DIR=273°
180	ACSPEC	WIND VEL=32kts
181	PRBUF	
182	RTN	RCW=31kts
183♦	LBL 08	TW=6kts
184	CLA	
185	ARCL X	VAR=0.0°
186♦	LBL 09	MH=280°
187	ACA	WIND DIR=240°
188	SF 13	WIND VEL=25kts
189	"KTS"	
190	ACA	LCW=16kts
191	PRBUF	HW=19kts
192	CF 13	
193	CLA	
194	END	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

PROGRAM DESCRIPTION I

Program Title Mach Number and True Airspeed

Contributor's Name

Address

City State/Country Zip Code

Program Description, Equations, Variables

This program converts calibrated airspeed (CAS) to mach number (M) and true airspeed (TAS). Inputs required are pressure altitude (PALT), aircraft recovery coefficient (C_T) and indicated air temperature (IAT). Values for recovery coefficient vary from 0.6 to 1.0, but 0.8 is a good value for most aircraft.

The formulas used are less accurate for mach numbers above 1.0 (i.e., supersonic flight).

$$\text{Pressure ratio}\left(\frac{P}{P_o}\right) = \left[\frac{518.67 - 3.566 \times .10^{-3}\ \text{PALT}}{518.67}\right]^{5.2563}$$

$$M^2 = 5\left[\left(\frac{P_o}{P}\left\{\left[1 + 0.2\left(\frac{CAS}{661.5}\right)^2\right]^{3.5} - 1\right\} + 1\right)^{0.2857} - 1\right]$$

$$TAS = 38.96M\sqrt{(IAT + 273)\left[C_T\left(\frac{1}{(1 + 0.2\,M^2)} - 1\right) + 1\right]}$$

SIZE: 008

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1	To compute mach number and true airspeed		XEQ TA	PALT= (ALT)?
2	Input pressure altitude.	PALT, ft.	R/S	CAS= (CAS)?
3	input calibrated airspeed.	CAS, kt.	R/S	CT= (CT)?
4	Input aircraft recovery coefficient.	C_T	R/S	IAT= (IAT)?
5	Input indicated air temperature.	IAT, °C	R/S	MACH M TAS= (TAS)

Necessary Accessories

Operating Limits and Warnings

LBL'TAS
END 177 BYTES
AVIGATION/RNAV ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
01	*LBL "TAS"	
02	SF 21	
03	FIX 0	
04	RCL 01	
05	"PALT="	
06	ARCL X	
07	"⊢?"	
08	PROMPT	
09	STO 01	
10	RCL 02	
11	"CAS="	
12	ARCL X	
13	"⊢?"	
14	PROMPT	
15	STO 02	
16	RCL 03	
17	"IAT="	
18	ARCL X	
19	"⊢?"	
20	PROMPT	
21	STO 03	
22	FIX 1	
23	RCL 04	
24	"CT="	
25	ARCL X	
26	"⊢?"	
27	PROMPT	
28	STO 04	
29	RCL 01	
30	-3566 E-6	
31	*	
32	518.67	
33	+	
34	LASTX	
35	/	
36	5.2563	
37	Y↑X	
38	STO 05	
39	RCL 02	
40	661.5	
41	/	
42	X↑2	
43	5	
44	/	
45	1	
46	+	
47	3.5	
48	Y↑X	
49	1	
50	-	
51	RCL 05	
52	/	
53	1	
54	+	
55	3.5	
56	1/X	
57	Y↑X	
58	1	
59	-	
60	5	
61	*	
62	SQRT	
63	STO 06	
64	FIX 2	
65	"MACH "	
66	ARCL X	
67	AVIEW	
68	RCL 06	
69	X↑2	
70	5	
71	/	
72	1	
73	+	
74	1/X	
75	1	
76	-	
77	RCL 04	
78	*	
79	1	
80	+	
81	273	
82	RCL 03	
83	+	
84	*	
85	SQRT	
86	RCL 06	
87	*	
88	38.96	
89	*	
90	FIX 0	
91	"TAS="	
92	ARCL X	
93	AVIEW	
94	END	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook

TRIGONOMETRY

TRIGONOMETRIC FUNCTIONS IN A RIGHT-ANGLED TRIANGLE

If A, B, and C are the vertices (C the right angle), and a, b, and h the sides opposite respectively,

$$\text{sine } A = \sin A = \frac{a}{h}, \qquad \text{cosine } A = \cos A = \frac{b}{h},$$

$$\text{tangent } A = \tan A = \frac{a}{b}, \qquad \text{cotangent } A = \cot A = \operatorname{ctn} A = \frac{b}{a},$$

$$\text{secant } A = \sec A = \frac{h}{b}, \qquad \text{cosecant } A = \csc A = \frac{h}{a}.$$

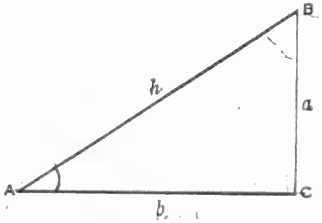


Fig. 4

$$\text{exsecant } A = \operatorname{exsec} A = \sec A - 1$$

$$\text{versine } A = \operatorname{vers} A = 1 - \cos A$$

$$\text{coversine } A = \operatorname{covers} A = 1 - \sin A$$

$$\text{haversine } A = \operatorname{hav} A = \tfrac{1}{2} \operatorname{vers} A$$

RELATIONS BETWEEN DEGREE OF ACCURACY OF COMPUTED LENGTHS AND ANGLES

When solving a triangle for any of its parts the following should be observed:

Length to:	(requires)	Angle to:
2 significant digits		nearest 30′ = 0.5°
3 significant digits		nearest 05′ = 0.083°
4 significant digits		nearest 01′ = 0.0167°
5 significant digits		nearest 0.1′ = 0.00167°

SIGNS AND LIMITS OF VALUE ASSUMED BY THE FUNCTIONS

Function	Quadrant I		Quadrant II		Quadrant III		Quadrant IV	
	Sign	Value	Sign	Value	Sign	Value	Sign	Value
sin.....	+	0 to 1	+	1 to 0	−	0 to 1	−	1 to 0
cos.....	+	1 to 0	−	0 to 1	−	1 to 0	+	0 to 1
tan.....	+	0 to ∞	−	∞ to 0	+	0 to ∞	−	∞ to 0
cot.....	+	∞ to 0	−	0 to ∞	+	∞ to 0	−	0 to ∞
sec.....	+	1 to ∞	−	∞ to 1	−	1 to ∞	+	∞ to 1
cosec.....	+	∞ to 1	+	1 to ∞	−	∞ to 1	−	1 to ∞

VALUE OF THE FUNCTIONS OF VARIOUS ANGLES

	0°	30°	45°	60°	90°	180°	270°
sin.....	0	$\frac{1}{2}$	$\frac{1}{2}\sqrt{2}$	$\frac{1}{2}\sqrt{3}$	1	0	−1
cos.....	1	$\frac{1}{2}\sqrt{3}$	$\frac{1}{2}\sqrt{2}$	$\frac{1}{2}$	0	−1	0
tan.....	0	$\frac{1}{3}\sqrt{3}$	1	$\sqrt{3}$	∞	0	∞
cot.....	∞	$\sqrt{3}$	1	$\frac{1}{3}\sqrt{3}$	0	∞	0
sec.....	1	$\frac{2\sqrt{3}}{3}$	$\sqrt{2}$	2	∞	−1	∞
cosec.....	∞	2	$\sqrt{2}$	$\frac{2\sqrt{3}}{3}$	1	∞	−1

EXPONENTIAL DEFINITIONS OF CIRCULAR FUNCTIONS

$$\sin x = \frac{1}{2i}(e^{ix} - e^{-ix}) \qquad \operatorname{cosec} x = \frac{2i}{e^{ix} - e^{-ix}}$$

$$(i^2 = -1)$$

$$\cos x = \frac{e^{ix} + e^{-ix}}{2} \qquad \sec x = \frac{2}{e^{ix} + e^{-ix}}$$

$$\tan x = \frac{e^{ix} - e^{-ix}}{ie^{ix} + ie^{-ix}} \qquad \cot x = \frac{ie^{ix} + ie^{-ix}}{e^{ix} - e^{-ix}}$$

RELATIONS OF THE FUNCTIONS

$$\sin x = \frac{1}{\operatorname{cosec} x}. \qquad \operatorname{cosec} x = \frac{1}{\sin x}.$$

$$\cos x = \frac{1}{\sec x}. \qquad \sec x = \frac{1}{\cos x}.$$

$$\tan x = \frac{1}{\cot x} = \frac{\sin x}{\cos x}. \qquad \sin^2 x + \cos^2 x = 1.$$

$$\cot x = \frac{1}{\tan x} = \frac{\cos x}{\sin x}. \qquad 1 + \tan^2 x = \sec^2 x.$$

$$1 + \cot^2 x = \operatorname{cosec}^2 x.$$

$$*\sin x = \pm\sqrt{1 - \cos^2 x}. \qquad *\cos x = \pm\sqrt{1 - \sin^2 x}.$$

$$*\tan x = \pm\sqrt{\sec^2 x - 1}. \qquad *\sec x = \pm\sqrt{\tan^2 x + 1}.$$

$$*\cot x = \pm\sqrt{\operatorname{cosec}^2 x - 1}. \qquad *\operatorname{cosec} x = \pm\sqrt{\cot^2 x + 1}.$$

$$\sin x = \cos(90° - x) = \sin(180° - x).$$

$$\cos x = \sin(90° - x) = -\cos(180° - x).$$

$$\tan x = \cot(90° - x) = -\tan(180° - x).$$

$$\cot x = \tan(90° - x) = -\cot(180° - x).$$

$$\operatorname{cosec} x = \cot\frac{x}{2} - \cot x.$$

* The sign in front of radical depends on quadrant in which x falls.

FUNCTIONS OF SUMS OF ANGLES

$$\sin(x \pm y) = \sin x \cos y \pm \cos x \sin y.$$
$$\cos(x \pm y) = \cos x \cos y \mp \sin x \sin y.$$
$$\tan(x \pm y) = \frac{\tan x \pm \tan y}{1 \mp \tan x \tan y}.$$

FUNCTIONS OF MULTIPLE ANGLES

$$\sin 2x = 2 \sin x \cos x.$$
$$\cos 2x = \cos^2 x - \sin^2 x = 2\cos^2 x - 1 = 1 - 2\sin^2 x.$$
$$\sin 3x = 3 \sin x - 4 \sin^3 x.$$
$$\cos 3x = 4 \cos^3 x - 3 \cos x.$$
$$\sin 4x = 8 \cos^3 x \sin x - 4 \cos x \sin x.$$
$$\cos 4x = 8 \cos^4 x - 8 \cos^2 x + 1.$$
$$\sin 5x = 5 \sin x - 20 \sin^3 x + 16 \sin^5 x.$$
$$\cos 5x = 16 \cos^5 x - 20 \cos^3 x + 5 \cos x.$$
$$\sin 6x = 32 \cos^5 x \sin x - 32 \cos^3 x \sin x + 6 \cos x \sin x.$$
$$\cos 6x = 32 \cos^6 x - 48 \cos^4 x + 18 \cos^2 x - 1.$$
$$\tan 2x = \frac{2 \tan x}{1 - \tan^2 x}.$$
$$\cot 2x = \frac{\cot^2 x - 1}{2 \cot x}.$$
$$\tan 3x = \frac{3 \tan x - \tan^3 x}{1 - 3 \tan^2 x}.$$
$$*\sin \tfrac{1}{2}x = \pm \sqrt{\frac{1 - \cos x}{2}}$$
$$*\cos \tfrac{1}{2}x = \pm \sqrt{\frac{1 + \cos x}{2}}.$$
$$*\tan \tfrac{1}{2}x = \pm \sqrt{\frac{1 - \cos x}{1 + \cos x}} = \frac{1 - \cos x}{\sin x} = \frac{\sin x}{1 + \cos x}.$$

* The sign in front of radical depends on quadrant in which x falls.

MISCELLANEOUS RELATIONS

$$\sin x \pm \sin y = 2 \sin \tfrac{1}{2}(x \pm y) \cdot \cos \tfrac{1}{2}(x \mp y).$$
$$\cos x + \cos y = 2 \cos \tfrac{1}{2}(x + y) \cdot \cos \tfrac{1}{2}(x - y).$$
$$\cos x - \cos y = -2 \sin \tfrac{1}{2}(x + y) \cdot \sin \tfrac{1}{2}(x - y).$$
$$\sin x \cos y = \tfrac{1}{2}[\sin(x + y) + \sin(x - y)]$$
$$\cos x \sin y = \tfrac{1}{2}[\sin(x + y) - \sin(x - y)]$$
$$\cos x \cos y = \tfrac{1}{2}[\cos(x + y) + \cos(x - y)]$$
$$\sin x \sin y = \tfrac{1}{2}[\cos(x - y) - \cos(x + y)]$$
$$\tan x \pm \tan y = \frac{\sin(x \pm y)}{\cos x \cdot \cos y}. \quad \cot x \pm \cot y = \frac{\pm \sin(x \pm y)}{\sin x \cdot \sin y}.$$
$$\frac{1 + \tan x}{1 - \tan x} = \tan(45° + x). \quad \frac{\cot x + 1}{\cot x - 1} = \cot(45° - x).$$
$$\frac{\sin x \pm \sin y}{\cos x + \cos y} = \tan \tfrac{1}{2}(x \pm y).$$
$$\frac{\sin x \pm \sin y}{\cos x - \cos y} = -\cot \tfrac{1}{2}(x \mp y).$$
$$\frac{\sin x + \sin y}{\sin x - \sin y} = \frac{\tan \tfrac{1}{2}(x + y)}{\tan \tfrac{1}{2}(x - y)}.$$
$$\sin^2 x - \sin^2 y = \sin(x + y) \cdot \sin(x - y).$$
$$\cos^2 x - \cos^2 y = -\sin(x + y) \sin(x - y).$$
$$\cos^2 x - \sin^2 y = \cos(x + y) \cos(x - y).$$

INVERSE TRIGONOMETRIC FUNCTIONS

The following table lists each of the six inverse trigonometric functions together with the interval of its principal value:

Function	Interval containing principal value	
	x positive or zero	x negative
$y = \sin^{-1} x$ and $\tan^{-1} x$	$0 \leqq y \leqq \pi/2$	$-\pi/2 \leqq y < 0$
$y = \cos^{-1} x$ and $\cot^{-1} x$	$0 \leqq y \leqq \pi/2$	$\pi/2 < y \leqq \pi$
$y = \sec^{-1} x$ and $\csc^{-1} x$	$0 \leqq y \leqq \pi/2$	$-\pi \leqq y \leqq -\pi/2$

Usually the first letter in "arc" or the name of the inverse trigonometric functions is capitalized if the principal value is desired. Thus

$$\text{Arc sin } \frac{1}{2} = \text{Sin}^{-1} \frac{1}{2} = \frac{\pi}{6},$$

while

$$\text{arc sin } \frac{1}{2} = \frac{\pi}{6} + 2\pi n \text{ or } \frac{5\pi}{6} + 2\pi n$$

In the calculus both for differentiation or integral formulas, capitalization is not adhered to strictly, but principal values are always understood for inverse trigonometric functions when used unless specifically stated otherwise.

RELATIONS BETWEEN SIDES AND ANGLES OF ANY PLANE TRIANGLE

In a triangle with angles A, B, and C and sides opposite a, b, and c respectively,

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} = \text{diameter of the circumscribed circle.}$$

$$a^2 = b^2 + c^2 - 2bc \cos A.$$

$$a = b \cos C + c \cos B.$$

$$\cos A = \frac{b^2 + c^2 - a^2}{2bc}.$$

$$\tan \frac{A - B}{2} = \frac{a - b}{a + b} \cot \frac{C}{2}.$$

$$\sin A = \frac{2}{bc}\sqrt{s(s-a)(s-b)(s-c)},$$

where $s = \frac{1}{2}(a + b + c)$ and $r = \sqrt{\frac{(s-a)(s-b)(s-c)}{s}}$.

$$\sin \frac{A}{2} = \sqrt{\frac{(s-b)(s-c)}{bc}}.$$

$$\cos \frac{A}{2} = \sqrt{\frac{s(s-a)}{bc}}.$$

$$\tan \frac{A}{2} = \sqrt{\frac{(s-b)(s-c)}{s(s-a)}} = \frac{r}{s-a}.$$

$$\frac{a+b}{a-b} = \frac{\sin A + \sin B}{\sin A - \sin B} = \frac{\tan \frac{1}{2}(A+B)}{\tan \frac{1}{2}(A-B)} = \frac{\cot \frac{1}{2} C}{\tan \frac{1}{2}(A-B)}.$$

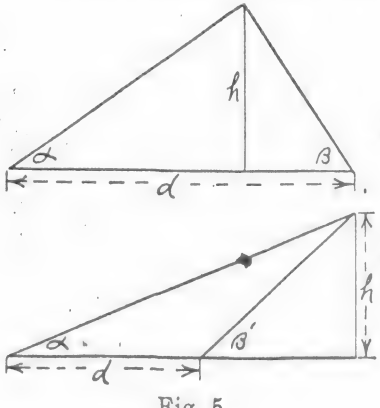


Fig. 5

$$h = d \frac{\sin \alpha \sin \beta}{\sin (\alpha + \beta)} = \frac{d}{\cot \alpha + \cot \beta}$$

Similarly

$$h = d \frac{\sin \alpha \sin \beta'}{\sin (\beta' - \alpha)} = \frac{d}{\cot \alpha - \cot \beta'}$$

RELATIONS IN ANY SPHERICAL TRIANGLE

If A, B and C be the three angles and a, b, and c the opposite sides,

$$\frac{\sin A}{\sin a} = \frac{\sin B}{\sin b} = \frac{\sin C}{\sin c}.$$

$$\cos a = \cos b \cos c + \sin b \sin c \cos A = \frac{\cos b \cos (c \pm \theta)}{\cos \theta}$$

where $\tan \theta = \tan b \cos A$.

$$\cos A = -\cos B \cos C + \sin B \sin C \cos a.$$

$$\sin \tfrac{1}{2} A = \sqrt{\frac{\sin (s-b) \sin (s-c)}{\sin b \sin c}}$$

where $s = \frac{1}{2}(a + b + c)$.

$$\cos \tfrac{1}{2} A = \sqrt{\frac{\sin s \sin (s-a)}{\sin b \sin c}}.$$

$$\tan \tfrac{1}{2} A = \frac{r}{\sin (s-a)}$$

where $r = \sqrt{\frac{\sin (s-a) \sin (s-b) \sin (s-c)}{\sin s}}$

$$\cos \tfrac{1}{2} a = \sqrt{\frac{\cos (S-B) \cos (S-C)}{\sin B \sin C}}$$

where $S = \frac{1}{2}(A + B + C)$.

$$\sin \tfrac{1}{2} a = \sqrt{-\frac{\cos S \cos (S-A)}{\sin B \sin C}}.$$

$$\tan \tfrac{1}{2} a = R \cos (S - A)$$

where $R = \sqrt{\frac{-\cos S}{\cos (S-A) \cos (S-B) \cos (S-C)}}$.

$$\frac{\tan \frac{a+b}{2}}{\tan \frac{c}{2}} = \frac{\cos \frac{A-B}{2}}{\cos \frac{A+B}{2}}, \quad \frac{\tan \frac{A+B}{2}}{\cot \frac{C}{2}} = \frac{\cos \frac{a-b}{2}}{\cos \frac{a+b}{2}}.$$

$$\frac{\tan \frac{a-b}{2}}{\tan \frac{c}{2}} = \frac{\sin \frac{A-B}{2}}{\sin \frac{A+B}{2}}, \quad \frac{\tan \frac{A-B}{2}}{\cot \frac{C}{2}} = \frac{\sin \frac{a-b}{2}}{\sin \frac{a+b}{2}}.$$

$$\operatorname{hav} a = \operatorname{hav} (b - c) + \sin b \sin c \operatorname{hav} A$$

$$\operatorname{hav} A = \frac{\sqrt{\operatorname{hav} [a + (b-c)] \operatorname{hav} [a - (b-c)]}}{\sin b \sin c}$$

TRANSFORMATION OF COORDINATES

Rectangular System

(1) Translation only of axes parallel to themselves.
The coordinates of new origin with respect to old axes: $x = h$, $y = k$. Primed letters designate new coordinates.

$$x' = x - h \qquad x = x' + h$$
$$y' = y - k \qquad y = y' + k$$

(2) Rotation of axes with fixed origin.

Angle of rotation $= \theta$

$$x' = x\cos\theta + y\sin\theta \qquad x = x'\cos\theta - y'\sin\theta$$
$$y' = y\cos\theta - x\sin\theta \qquad y = y'\cos\theta + x'\sin\theta$$

(3) Origin translated and axes rotated.
Symbols same as above

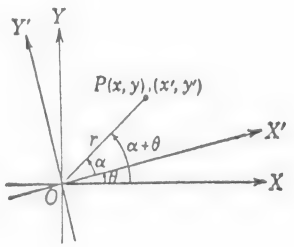
$$x' = (x - h)\cos\theta + (y - k)\sin\theta$$
$$y' = (y - k)\cos\theta - (x - h)\sin\theta$$
$$x = x'\cos\theta - y'\sin\theta + h$$
$$y = y'\cos\theta + x'\sin\theta + k$$

Relation between Rectangular and Polar Coordinates

$$x = r\cos\theta \qquad r = \sqrt{x^2 + y^2} \qquad \sin\theta = \frac{y}{\sqrt{x^2 + y^2}}$$
$$y = r\sin\theta \qquad \theta = \tan^{-1}\frac{y}{x} \qquad \cos\theta = \frac{x}{\sqrt{x^2 + y^2}}$$

Rotation of Polar Axes through Angle θ

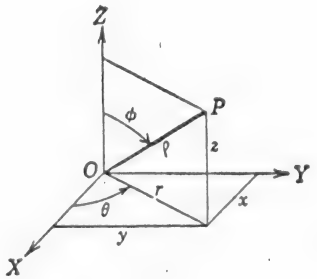
$$x' = r\cos\alpha$$
$$y' = r\sin\alpha$$
$$x = r\cos(\alpha + \theta)$$
$$y = r\sin(\alpha + \theta)$$

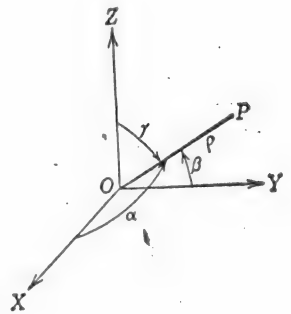


TRANSFORMATION OF COORDINATES (Continued)
SOLID ANALYTICAL GEOMETRY

Space Coordinates

1. Rectangular System x, y, z.
2. Cylindrical System r, θ, z.
3. Spherical System ρ, θ, ϕ. In certain situations it is desirable to interchange the symbols ϕ for θ and vice versa.
4. Polar Space System $\rho, \alpha, \beta, \gamma$.





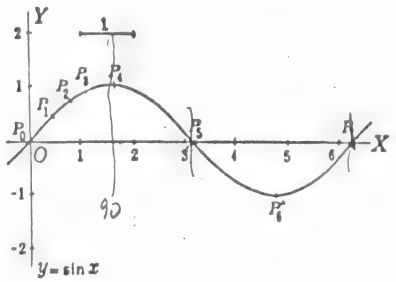
Relations of Coordinates of Systems in Terms of x, y, z

Cylindrical	Spherical	Polar Space
$r = \sqrt{x^2 + y^2}$	$\rho = \sqrt{x^2 + y^2 + z^2}$	$\rho = \sqrt{x^2 + y^2 + z^2}$
$\theta = \tan^{-1}\frac{y}{x}$	$\theta = \tan^{-1}\frac{y}{x}$	$\alpha = \cos^{-1}\left(\frac{x}{\sqrt{x^2 + y^2 + z^2}}\right)$
$z = z$	$\phi = \cos^{-1}\left(\frac{z}{\sqrt{x^2 + y^2 + z^2}}\right)$	$\beta = \cos^{-1}\left(\frac{y}{\sqrt{x^2 + y^2 + z^2}}\right)$
		$\gamma = \cos^{-1}\left(\frac{z}{\sqrt{x^2 + y^2 + z^2}}\right)$

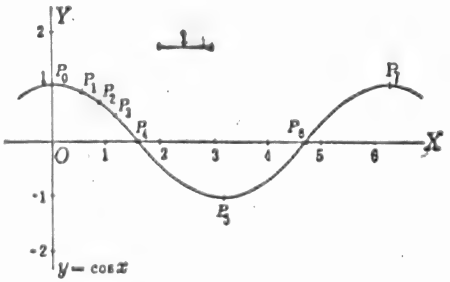
Relations of Rectangular Coordinates (x, y, z) in Terms of Cylindrical, Spherical and Polar Space Coordinates

Cylindrical	Spherical	Polar Space
$x = r\cos\theta$ $y = r\sin\theta$ $z = z$	$x = \rho\sin\phi\cos\theta$ $y = \rho\sin\phi\sin\theta$ $z = \rho\cos\phi$	$x = \rho\cos\alpha$ $y = \rho\cos\beta$ $z = \rho\cos\gamma$

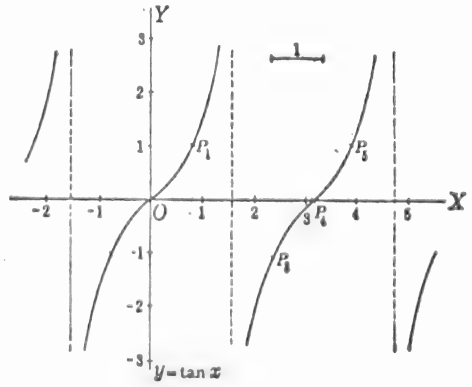
*GRAPHS OF THE TRIGONOMETRIC FUNCTIONS



x	y	Point
0	0	$P_0(0, 0)$
$\frac{\pi}{6} = .52$	.50	$P_1(.52, .50)$
$\frac{\pi}{4} = .79$	.71	$P_2(.79, .71)$
$\frac{\pi}{3} = 1.05$	.87	$P_3(1.05, .87)$
$\frac{\pi}{2} = 1.57$	1	$P_4(1.57, 1)$
$\pi = 3.14$	0	$P_5(3.14, 0)$
$\frac{3\pi}{2} = 4.71$	-1	$P_6(4.71, -1)$
$2\pi = 6.28$	0	$P_7(6.28, 0)$

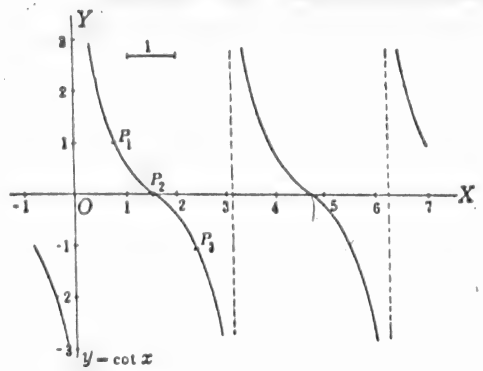


x	y	Point
0	1	$P_0(0, 1)$
$\frac{\pi}{6} = .52$	.87	$P_1(.52, .87)$
$\frac{\pi}{4} = .79$	.71	$P_2(.79, .71)$
$\frac{\pi}{3} = 1.05$	.5	$P_3(1.05, .5)$
$\frac{\pi}{2} = 1.57$	0	$P_4(1.57, 0)$
$\pi = 3.14$	-1	$P_5(3.14, -1)$
$\frac{3\pi}{2} = 4.71$	0	$P_6(4.71, 0)$
$2\pi = 6.28$	1	$P_7(6.28, 1)$

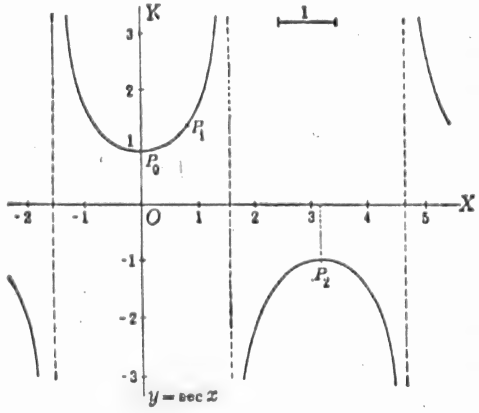


x	y	Point
0	0	$P_0(0, 0)$
$\frac{\pi}{4}$	1	$P_1(.79, 1)$
$\frac{\pi}{2}$	∞	.....
$\frac{3\pi}{4}$	-1	$P_3(2.36, -1)$
π	0	$P_4(3.14, 0)$
$\frac{5\pi}{4}$	1	$P_5(3.93, 1)$
$\frac{3\pi}{2}$	∞	.....
2π	0	$P_8(6.28, 0)$

GRAPHS OF THE TRIGONOMETRIC FUNCTIONS

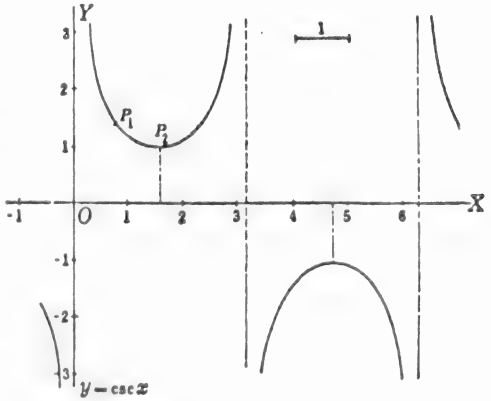


x	y	Point
0	$\pm\infty$	.....
$\frac{\pi}{4}$	1	$P_1(.79, 1)$
$\frac{\pi}{2}$	0	$P_2(1.57, 0)$
$\frac{3\pi}{4}$	-1	$P_3(2.36, -1)$
π	$\pm\infty$	.....



x	y	Point
0	1	$P_0(0, 1)$
$\frac{\pi}{4}$	$\sqrt{2}$	$P_1(.79, 1.4)$
$\frac{\pi}{2}$	$\pm\infty$	.....
π	-1	$P_2(3.14, -1)$

x	y	Point
0	$\pm\infty$	.....
$\frac{\pi}{4}$	$\sqrt{2}$	$P_1(.79, 1.4)$
$\frac{\pi}{2}$	1	$P_2(1.57, 1)$
π	$\pm\infty$	.....



	0	1	2	3	4	5	6	7	8	9		0	1	2	3	4	5	6	7	8	9	
9											9											9
8											8											8
7											7											7
6											6											6
5											5											5
4											4											4
3											3											3
2											2											2
1											1											1
0											0											0
	0	1	2	3	4	5	6	7	8	9		0	1	2	3	4	5	6	7	8	9	
9											9											9
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2											2											2
1											1											1
0											0											0
	0	1	2	3	4	5	6	7	8	9		0	1	2	3	4	5	6	7	8	9	
9											9											9
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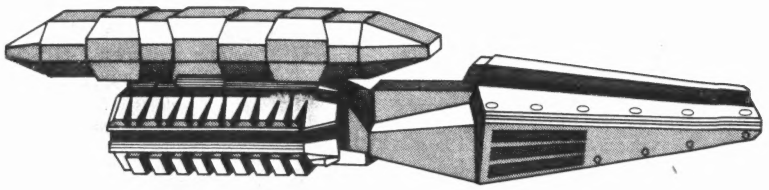
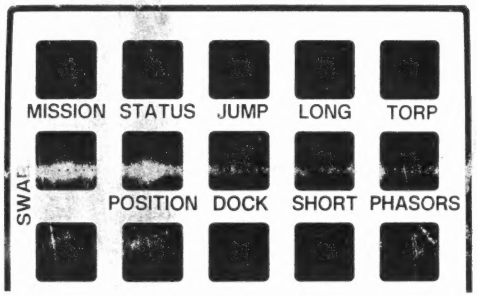
3											3											3
2											2											2
1											1											1
0											0											0
	0	1	2	3	4	5	6	7	8	9		0	1	2	3	4	5	6	7	8	9	

Playing boards for Submarine Hunt and Space War.
You might wish to use copies of this page for your games.

SPACE WAR





You are the commander of the Nuclear Powered Reconnoiterer (NPR) Sapphire. The NPR Sapphire is the sole guardian of justice in a vast galaxy that measures 10 quadrants by 10 quadrants. Within the galaxy somewhere, anchored among the blazing stars, lie groups of sinister, vile Alglogs, known throughout space as interstellar thieves and creators of cosmic mischief. Your mission, as commander of the NPR Sapphire, is to search out and destroy the fearsome Alglogs in as few stardays as possible.

Within the galaxy somewhere is a Base, a haven to which your ship may return in order to repair damage and resupply. The weapons carried by the Sapphire are torpedos, which are fired in a straight line and phasors, which send out computer-selected directional bursts of energy. In addition, your starship is equipped with short- and long-range scanners which can detect the presence of Alglogs or the Base in nearby space. One starday is used for each quadrant traversed during a hyperspace jump. Details of the orders available to you as commander are given below.

Mission

This command begins with a mission briefing. Here you are prompted with ***SEED?*** Input any number to randomly place the Base, the Sapphire and the enemy. It also determines the Alglog's strategy. You are then prompted ***GROUPS?***. The Alglogs fight in groups, each group in a different quadrant. Here you select the number of groups you wish to fight. The next prompt is ***ALGLOGS PER?*** Here you select the number of Alglog ships in each group. All Alglogs of a group are in one quadrant. The briefing ends with your position in the galaxy displayed by your on-board computer.

The galaxy is a 10 × 10 grid of quadrants; within each quadrant is a 10 × 10 grid of smaller areas called sectors. The quadrants are numbered 00 through 99, as are the sectors. A display of ***QD55 SC17*** means that the Sapphire is in quadrant 55, sector 17.

Long-Range Scan

The long-range scan covers all quadrants adjacent to and including that of the Sapphire. This scan will detect and report the presence of Alglogs or the Base in those quadrants. If neither are present, ***CLEAR*** will be displayed. Suppose objects are located in the quadrants as shown below.

6	61	62	63	64 Base	65 Alglog
5	51	52 Alglog	53 Sapphire	54	55
4	41	42	43	44 Alglog	45

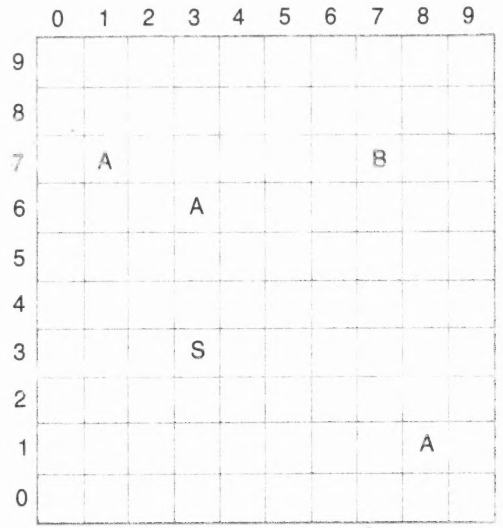
The long-range scan would include quadrants adjacent to quadrant 53 (QD53). The output would be as follows:

ENEMY QD 52
ENEMY QD 44
BASE QD 64

Short-Range Scan

The short-range scan gives a detailed picture of the quadrant in which the Sapphire is located. The output from the scan will tell you which sectors, if any, the Alglogs and the Base reside. If neither the Base nor Alglogs are in the quadrant, ***CLEAR*** will be displayed.

Suppose a quadrant looks as follows:



A Quadrant

The display after short-range scan would look as follows:

CONTACT MADE
ALGLOG SC 71
ALGLOG SC 18
ALGLOG SC 63
BASE SC 77

Also, flag 0, meaning contact was made, will be set on your instrument panel. Since the Alglogs can sense your short-range scan, they will know where you are. Thus, after a short-range scan an Alglog in the quadrant may open fire or move anywhere within the quadrant. The display may continue as follows:

ALGLOG FIRES
HIT
MINOR DAMAGE
ORDERS

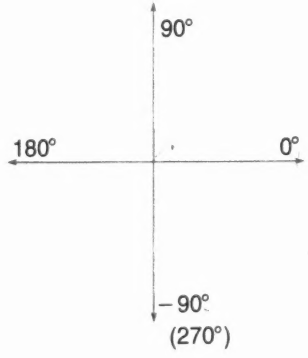
In this example, an Alglog opened fire on the Sapphire which sustained minor damage. If the Sapphire is hit a second time without having been repaired, the display will show ***SHIELDS GONE***. A third hit results in ***MAJOR DAMAGE***; then, if hit a fourth time, the display shows ***DESTROYED***, in which case the game is over, and you have definitely lost. Also note that Alglogs are not perfect marksmen; they often miss. Sometimes they are not alert and do not detect your presence after a short-range scan. In this case, they do nothing.

Since the Sapphire's weapons are directly tied into the firing computer, they will be effective only after the short-range scanner has made contact. When flag 0 is set, the Sapphire weapons are effective. You also are susceptible to being fired upon by the Alglogs.

Jump

A jump through hyperspace to any other part of the galaxy takes one starday per quadrant traversed. Of course, it seems to be instantaneous while aboard the Sapphire.

If the Sapphire were in the position shown in the long-range scan example, a logical move would be to go to quadrant 52 to attack the Alglog. To make a move, one specifies the angle θ and distance r to be covered. Orientation of angles is shown in the diagram below.



Angles must be input in degrees. The distance is specified in terms of quadrants. To move exactly one quadrant width, specify an r of 1. To move from QD 53 to QD 52, select $\theta = 180°$ and $r = 1$. Suppose one wished to move from QD 53 to QD 64. This would require an angle of 45° and a distance of $\sqrt{2}$. The output at the end of the jump routine is the Sapphire's new position.

When a jump is made, even if the Sapphire remains in the same quadrant, contact with Alglogs is broken since they cannot track the Sapphire through hyperspace. Flag 0 will no longer be lit on your instrument panel.

Torpedo

The Sapphire begins each mission with 6 torpedos. These torpedos are effective only within a quadrant and must pass within 5° of an Alglog ship to destroy it. Only one Alglog can be destroyed per torpedo. To fire a torpedo simply specify the angle of fire then press [E] . Remember, unless contact has been made (flag 0 set) you are wasting torpedos.

Phasers

Before each mission, the Sapphire is supplied with 500 units of energy available for firing phasers. Unlike torpedos, phaser direction is computer controlled. Distance is operator controlled. Ten units of energy per sector are required to reach and destroy an Alglog ship. The computer arbitrarily selects which Alglog ship within range is to be destroyed. If no ship is within range, or if contact has not been made with the short-range scanner, the energy will be wasted. If more phaser energy is specified than is available, the amount available is used. Thus, it is possible to specify enough energy to destroy an Alglog yet miss him.

Dock

The Sapphire may dock at the Base by moving into a sector adjacent to that of the base and then pressing [H] . Torpedos and energy will be replenished and damage will be repaired. This service takes 10 stardays.

Status

Mission status may be obtained at any time. It is ordered as follows:

Stardays from mission briefing to date;

Damage report;

Number of torpedos left;

Amount of energy left;

Number of Alglog ships left;

Sapphire's position.

If the Sapphire has been destroyed, mission status ends after the damage report.

Position

The position of the Sapphire may be obtained at any time. The output from this routine is ***QD*** ( ) ***SC*** ( ) where the number following ***QD*** is the quadrant, and the number following ***SC*** is the sector.

On Board Computer

The Sapphire contains a very powerful computer which can be used at any time to calculate inputs needed to jump or fire weapons. Use the 41C whenever desired but do not disturb the storage registers. All calculations must be done in the stack.

Note: The 41C may need to be taken out of user mode to use the top two rows.

Map of Galaxy

A map of the galaxy (playing board) is located on page 14.

Remarks:

1. When an order is selected when the printer is attached, it will print the results of that order and end with a prompt for new orders (***ORDERS***). When not using the printer, just continue pressing [R/S] and watching the results of your last order until you see the prompt ***ORDERS***. This prompt is the Sapphire's way of requesting a new command.
2. After steps 1 and 3 in the user instructions, it is possible to get the following prompt in the display: ***SIZE*** >= (nn). This prompt indicates that the size is not set large enough to execute the program. (Refer to pages 73 and 117 in the *Owner's Handbook*.) Reset the size to a number greater than or equal to the number in the display. Then, press [R/S] to continue.

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY SIZE: >14†
1	Get a mission and place overlay on calculator.		[XEQ] SWAR	SEED ?
2	Key in any number.	SEED	[R/S]	GROUPS?
3	Key in number of groups.	# groups	[R/S]	ALGLOGS PER?
4	Key in number of Alglogs per group.			
	Display shows Sapphire's position.	# alglogs per	[R/S]	QD( ) SC( )
			[R/S] *	ORDERS
	Select from the following orders (steps 5 through 12) until enemy or Sapphire is destroyed.			
5	For long-range scan		[D]	
	If enemy is found, lists enemy positions.			ENEMY QD( )
			[R/S] *	
	If base is found			BASE QD( )
			[R/S] *	ORDERS
	otherwise			CLEAR
			[R/S] *	ORDERS
	†SIZE=14 + (no. of groups) + ((no. of groups) × (no. of ALGLOGS per group))			
	*Press [R/S] if the printer is not attached.			

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
6	For short-range scan		[I]	
	If enemy is found,			CONTACT MADE
	lists enemy locations:		[R/S] *	ALGLOG SC( )
			:	:
	If base is found			BASE SC( )
	If contact was made with enemy		[R/S] *	(Possible Alglog retaliation)
				ORDERS
	otherwise			CLEAR
			[R/S] *	ORDERS
7	To jump, key in angle and distance. See	θ(DEG)	[ENTER↑]	
	Sapphire's new position.	r	[C]	QD( ) SC( )
			[R/S] *	ORDERS
8	To fire a torpedo, key in angle	θ (DEG)	[E]	
	If Alglog is hit			HIT
			[R/S] *	(damage report)
				(possible Alglog retaliation)
				ORDERS
	otherwise			MISS
			[R/S] *	(possible Alglog retailiation)
				ORDERS
9	To fire phasers, key in energy	ENERGY	[J]	(same as step 8)
10	To dock		[H]	
	If close enough to dock			DONE
			[R/S] *	ORDERS
	otherwise			NOT DONE
			[R/S] *	ORDERS
11	For mission status:		[B]	
	days on mission			( ) DAYS OUT
	amount of damage		[R/S] *	( ) DAMAGE
	no. of torpedos left		[R/S] *	TORPS ( )
	units of energy left		[R/S] *	ENERGY ( )
	no. of Alglogs left		[R/S] *	ALGLOGS ( )
	Sapphire's position		[R/S] *	QD ( ) SC( )
			[R/S] *	ORDERS
12	For Sapphire's position		[G]	QD ( ) SC( )
			[R/S] *	ORDERS
13	For new mission go to step 3.		[A]	GROUPS?
	*Press [R/S] if the printer is not attached.			